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Engerman et al.

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(54) **MULTI-SPEED GEARBOX WITH A GEAR-CLUTCH ASSEMBLY**

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(Continued)

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B60K 1/00	(2006.01)
B60T 1/00	(2006.01)
F16D 25/06	(2006.01)
F16D 25/10	(2006.01)
F16H 3/091	(2006.01)
F16H 61/30	(2006.01)
F16D 121/04	(2012.01)
F16D 127/02	(2012.01)

(52) **U.S. Cl.**

CPC ***F16H 37/0813*** (2013.01); ***B60K 1/00*** (2013.01); ***B60T 1/005*** (2013.01); ***F16D 25/06*** (2013.01); ***F16D 25/10*** (2013.01); ***F16H 3/091*** (2013.01); ***F16H 61/30*** (2013.01); *B60K 2001/001* (2013.01); *B60Y 2200/92* (2013.01); *F16D 2121/04* (2013.01); *F16D 2127/02* (2013.01); *F16H 2708/20* (2013.01)

(58) **Field of Classification Search**

CPC B60K 1/00; B60K 17/06; B60K 17/354; B60K 17/356; B60K 2001/001; F16D 13/52; F16D 25/0638; F16D 25/10; F16H 3/089; F16H 37/042; F16H 57/037; F16H 63/3026; F16H 2057/02034; F16H 2057/02052; F16H 2200/0021; F16H 2200/0034; B60Y 2400/424

See application file for complete search history.

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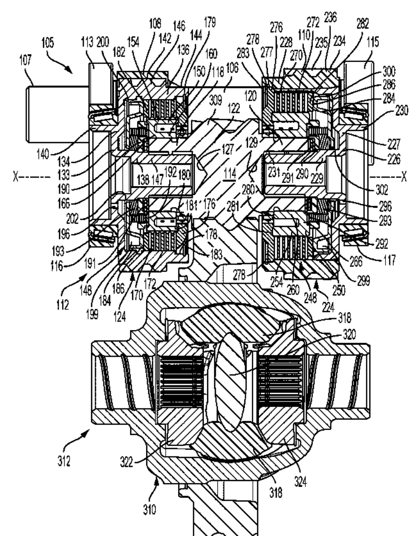
(57) **ABSTRACT**

An electric drive axle of a vehicle includes an electric motor having an output shaft. A compound idler assembly is connected to the electric motor. The compound idler assembly includes at least one gear-clutch assembly in driving engagement with the output shaft of the electric motor. A differential is connected to the compound idler assembly, and in selective driving engagement with the compound idler assembly.

10 Claims, 18 Drawing Sheets



SECTION B-B

Related U.S. Application Data

(60) Provisional application No. 62/818,492, filed on Mar. 14, 2019.

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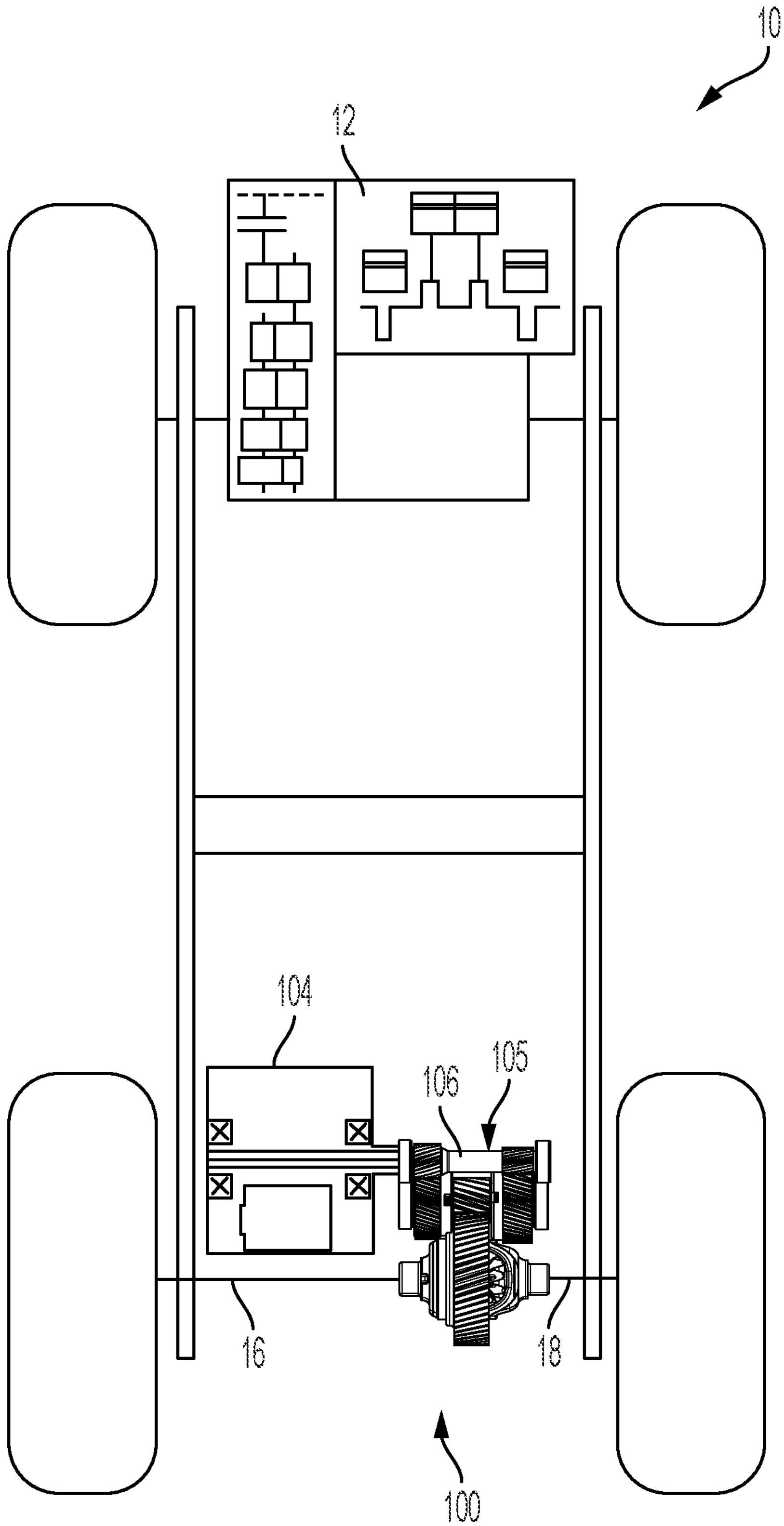

FIG. 1

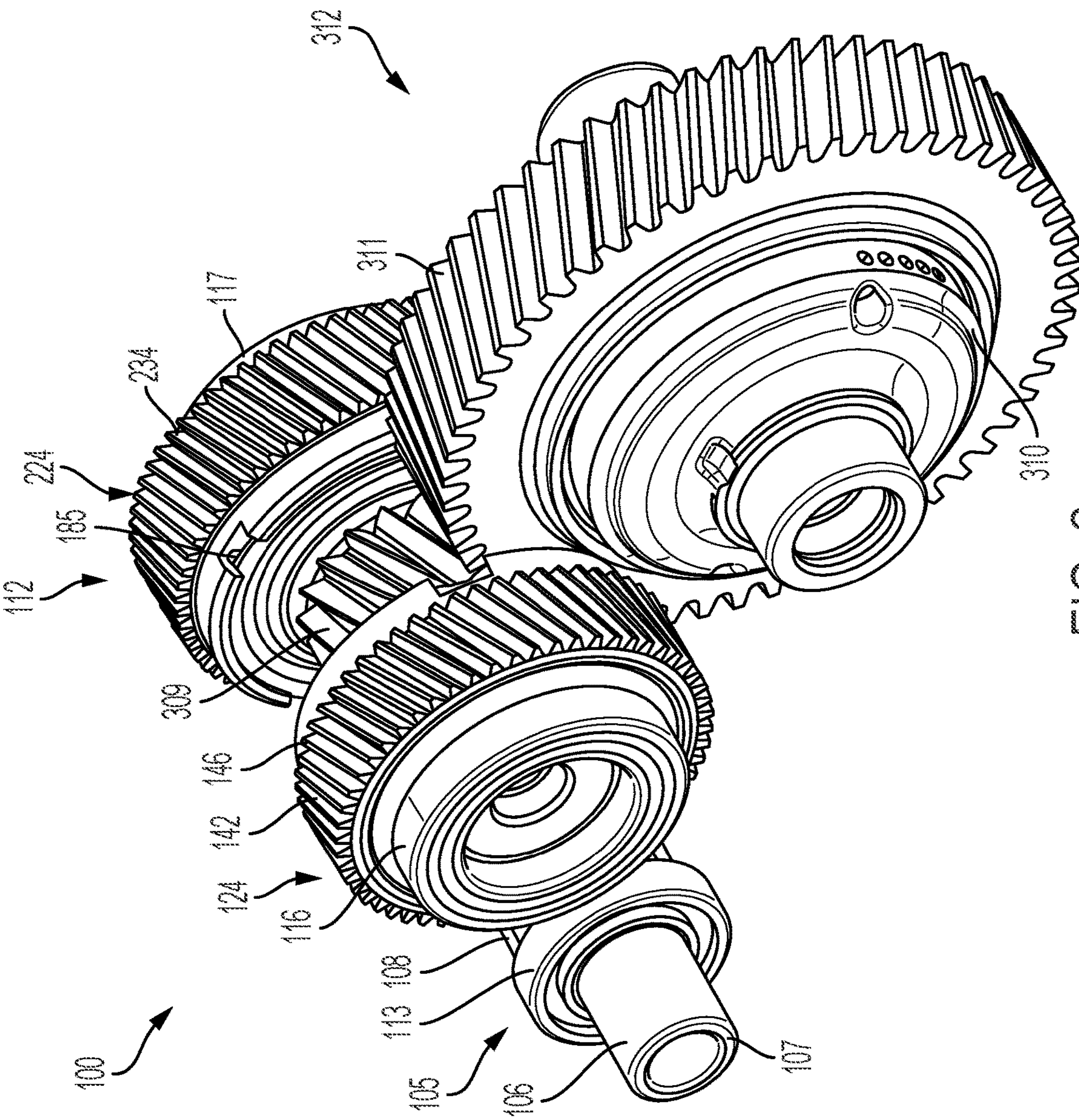
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FIG. 2

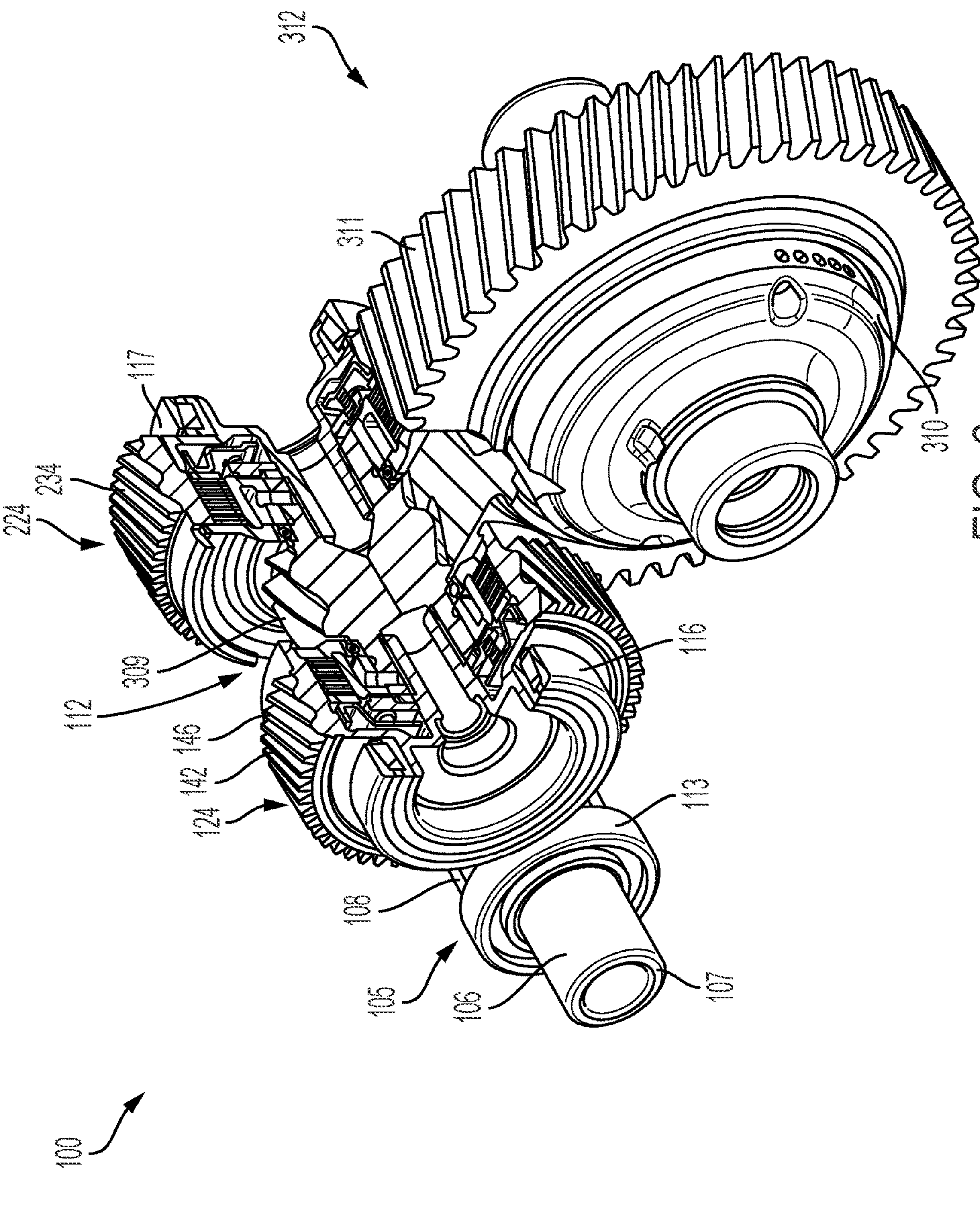
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FIG. 3

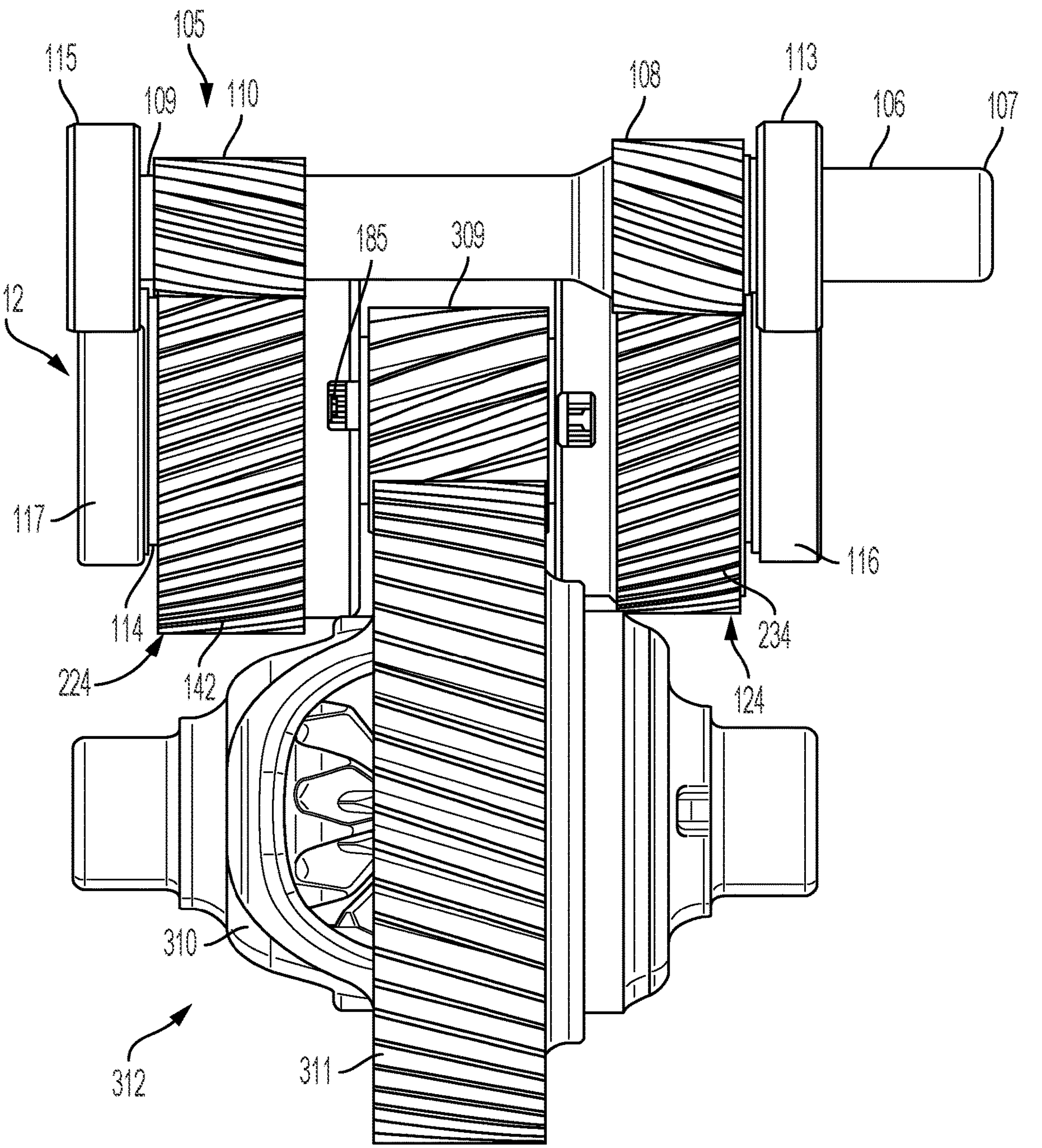
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FIG. 4

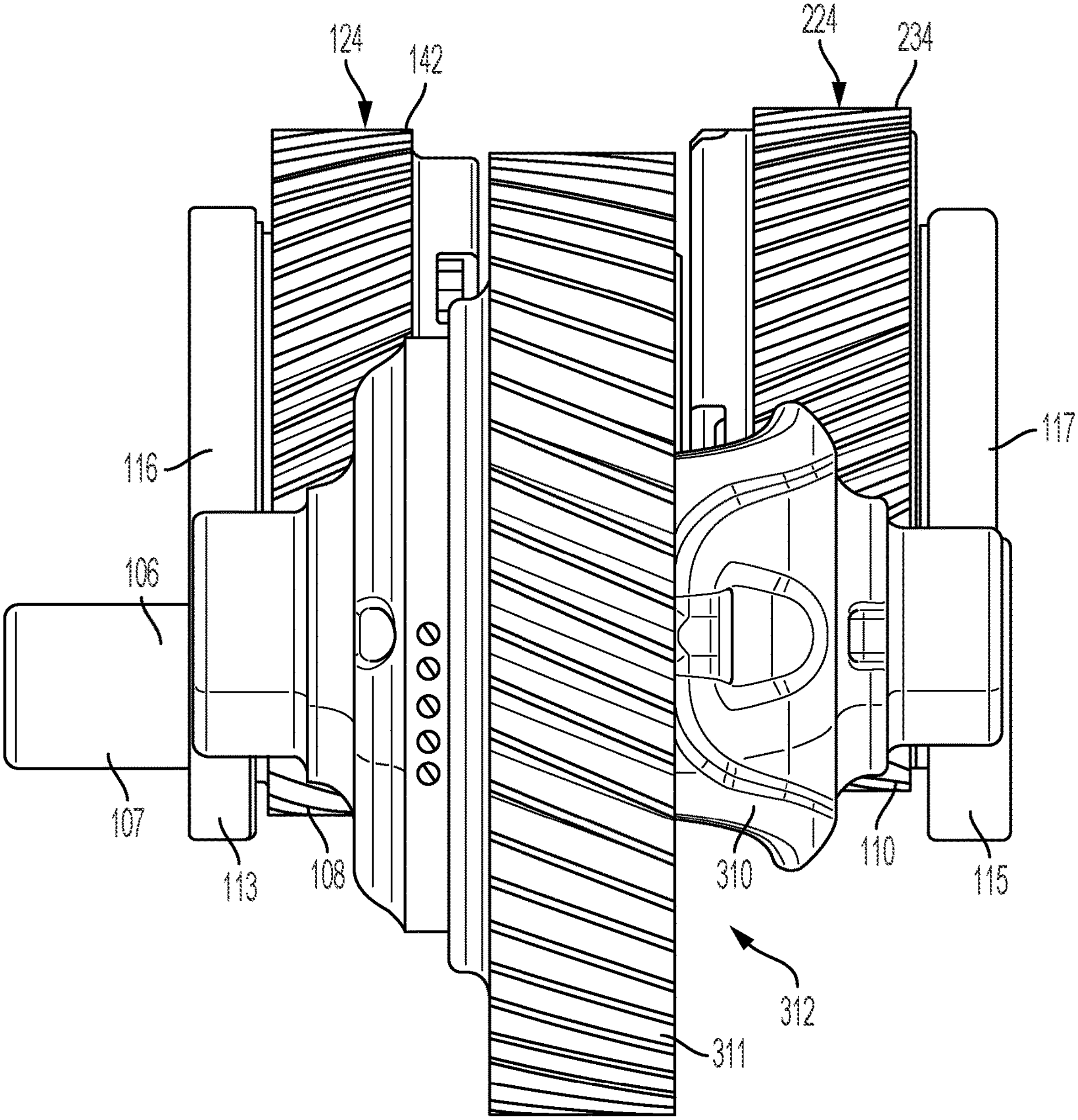


FIG. 5

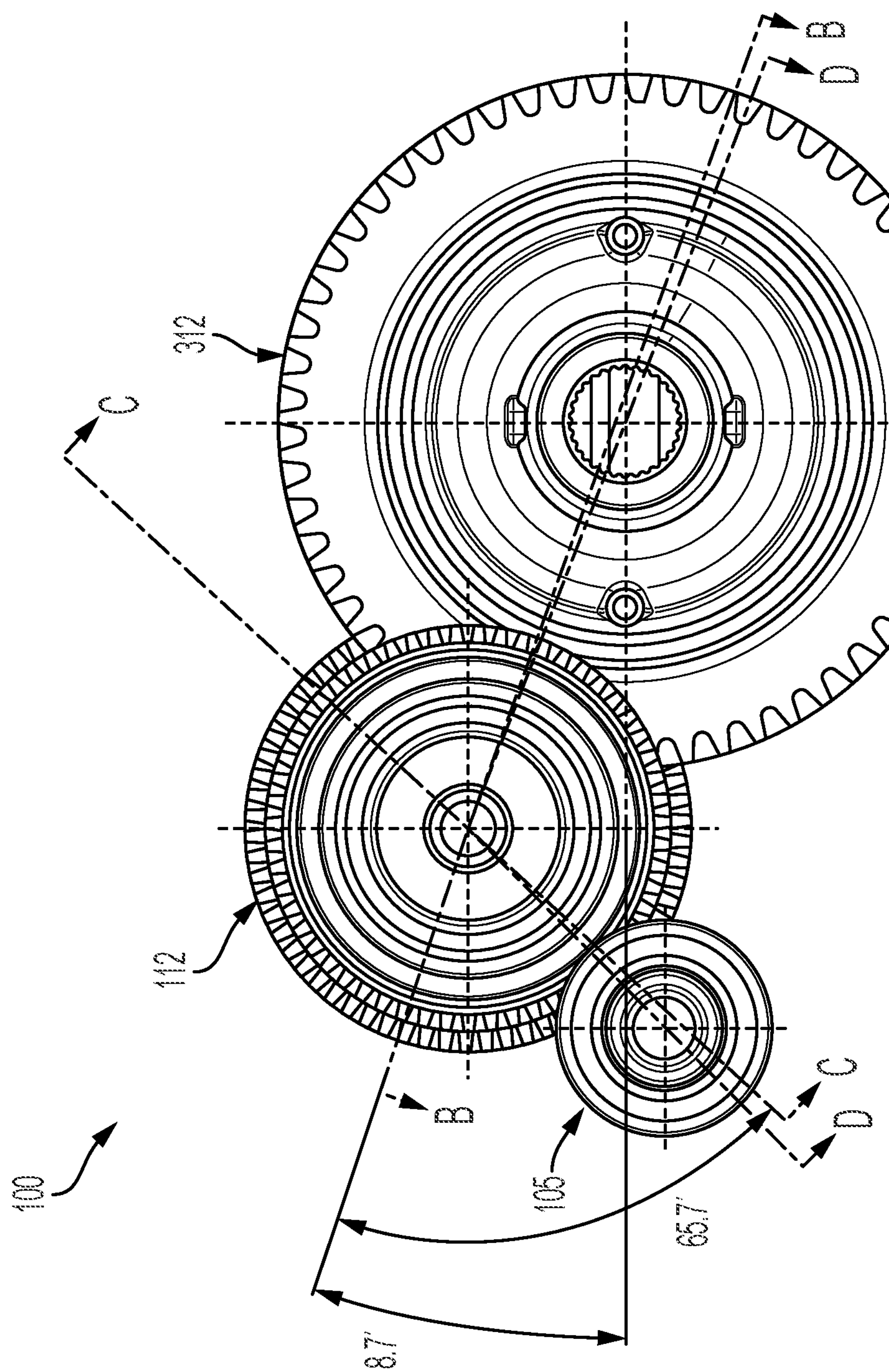


FIG. 6

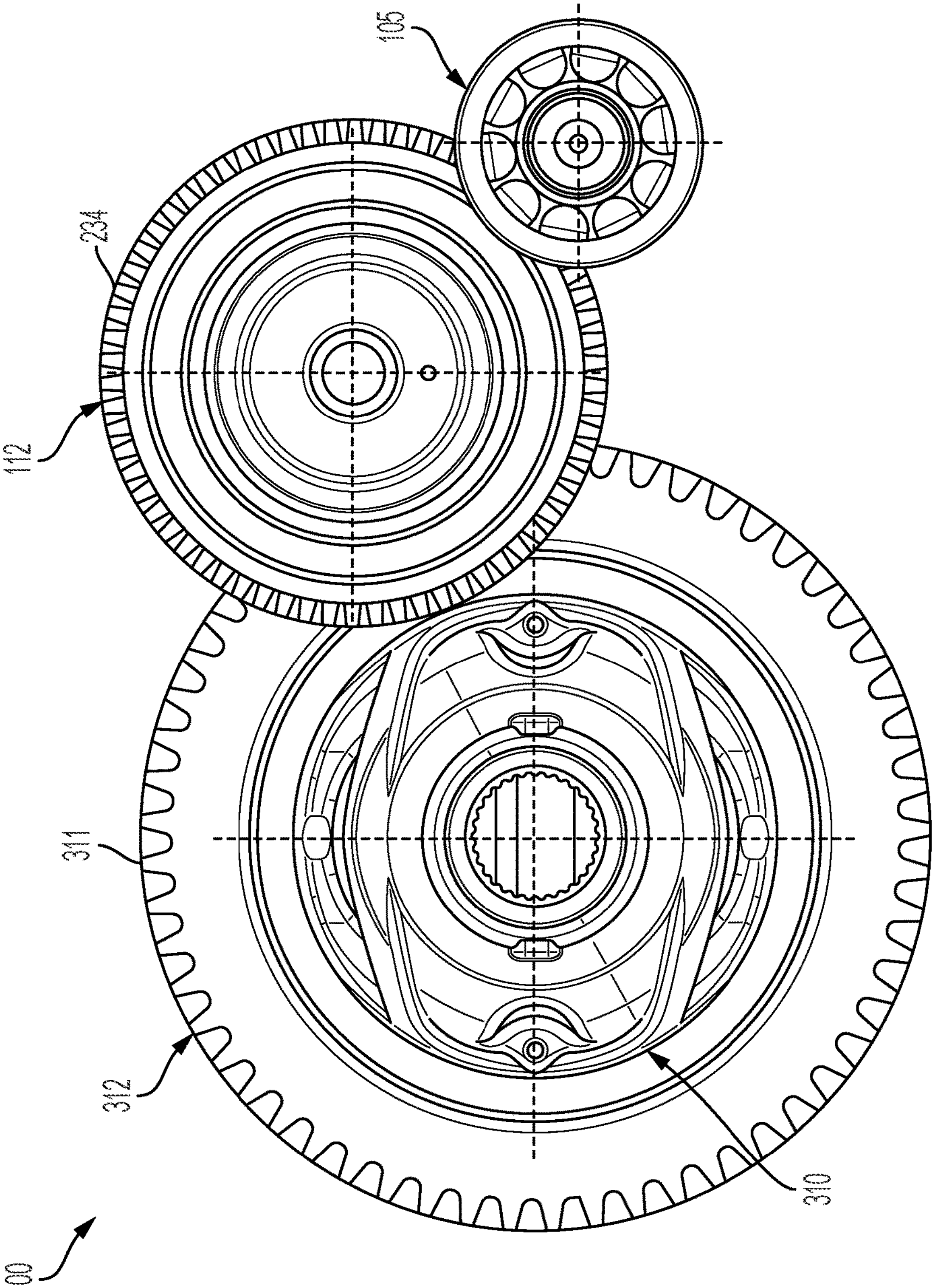
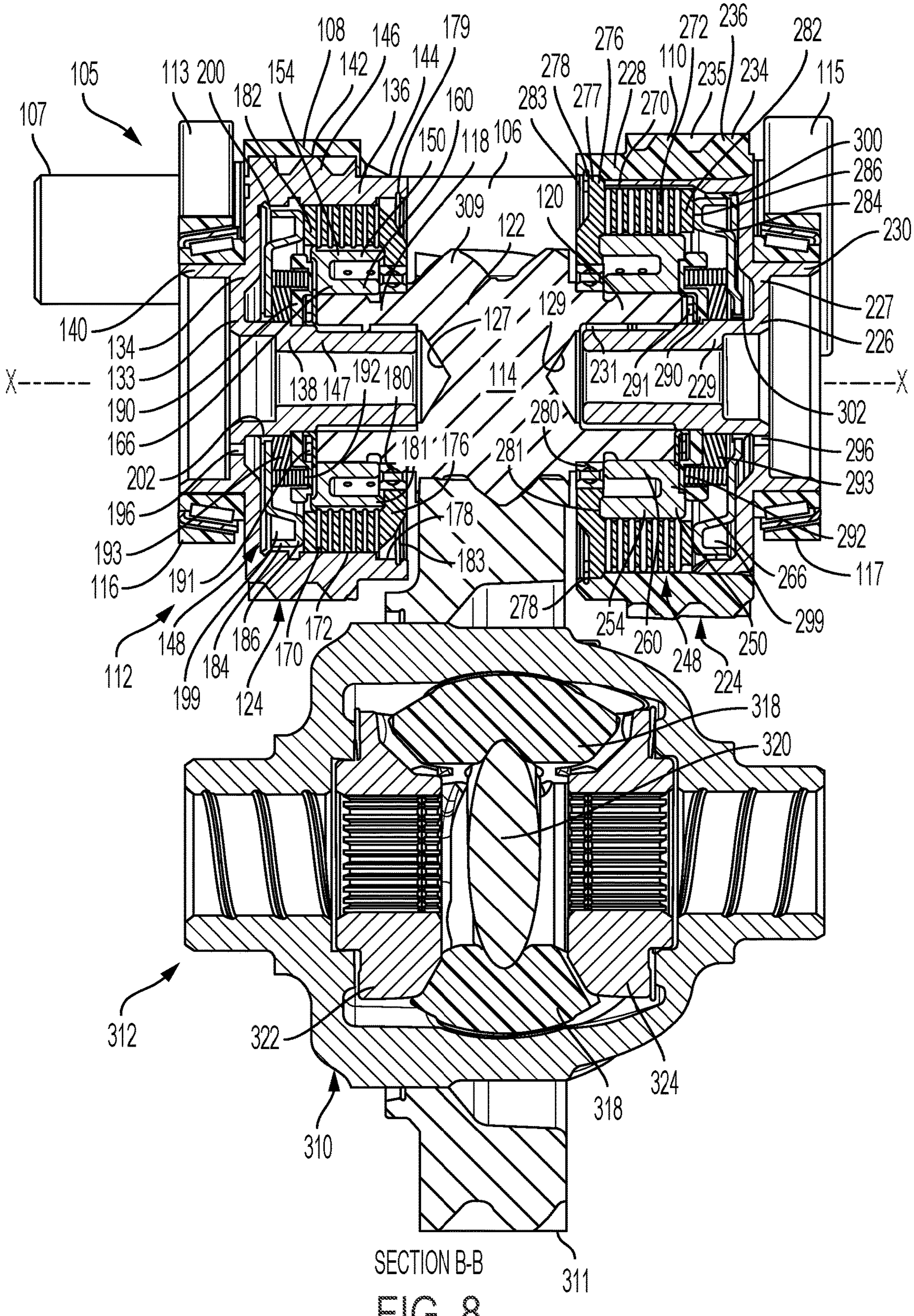


FIG. 7



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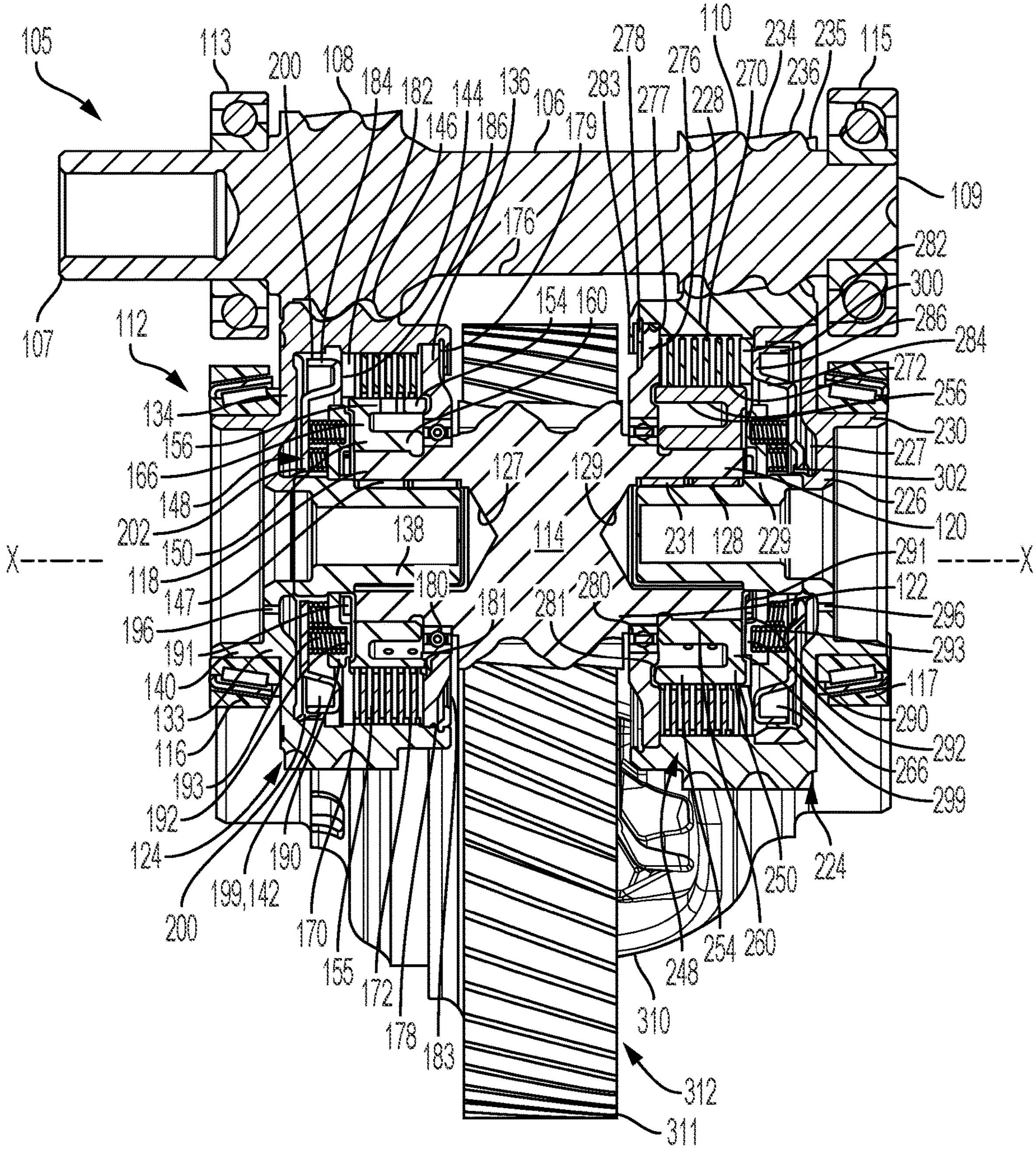
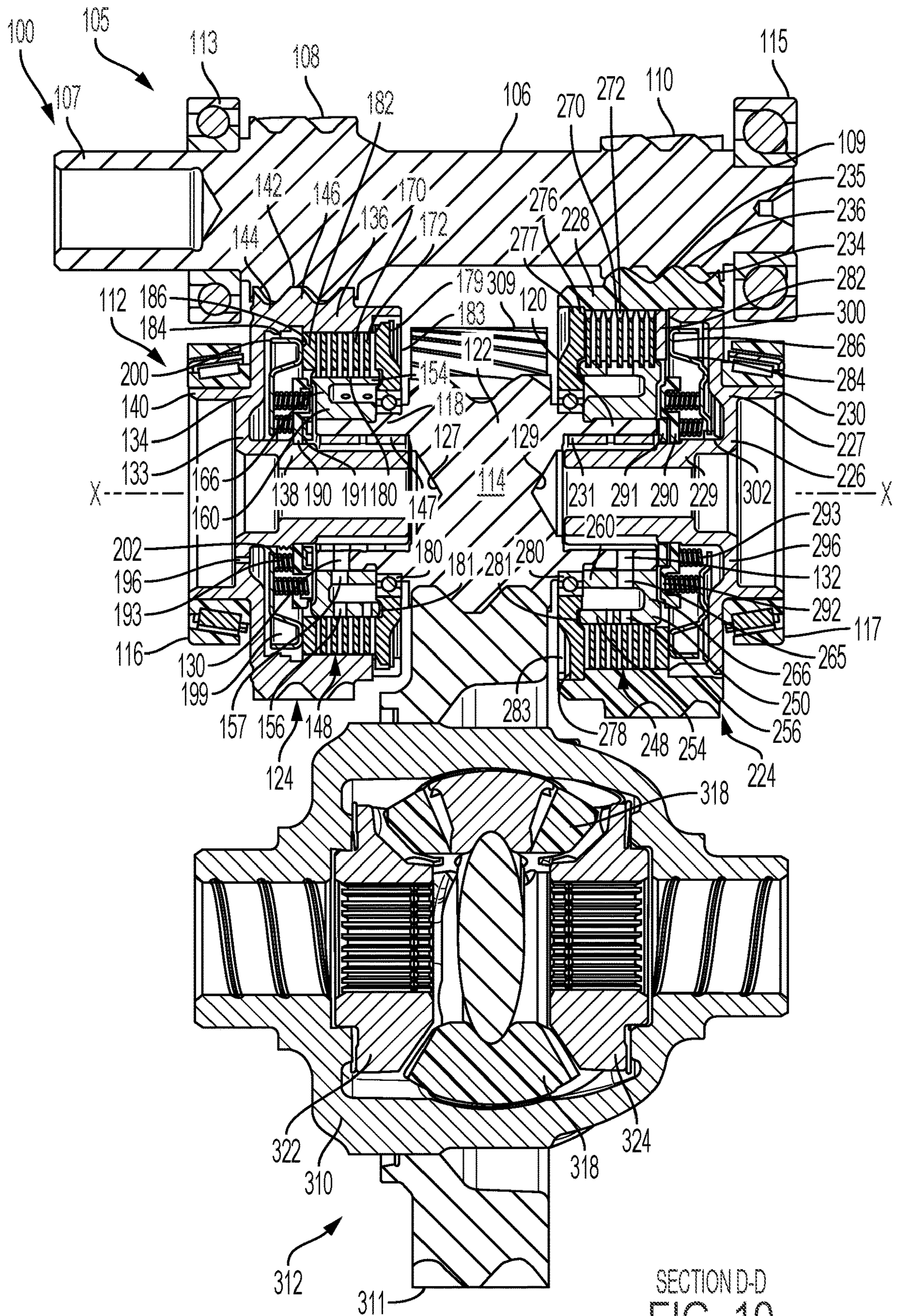
SECTION B-B

FIG. 8



SECTION C-C

FIG. 9



SECTION D-D
FIG. 10

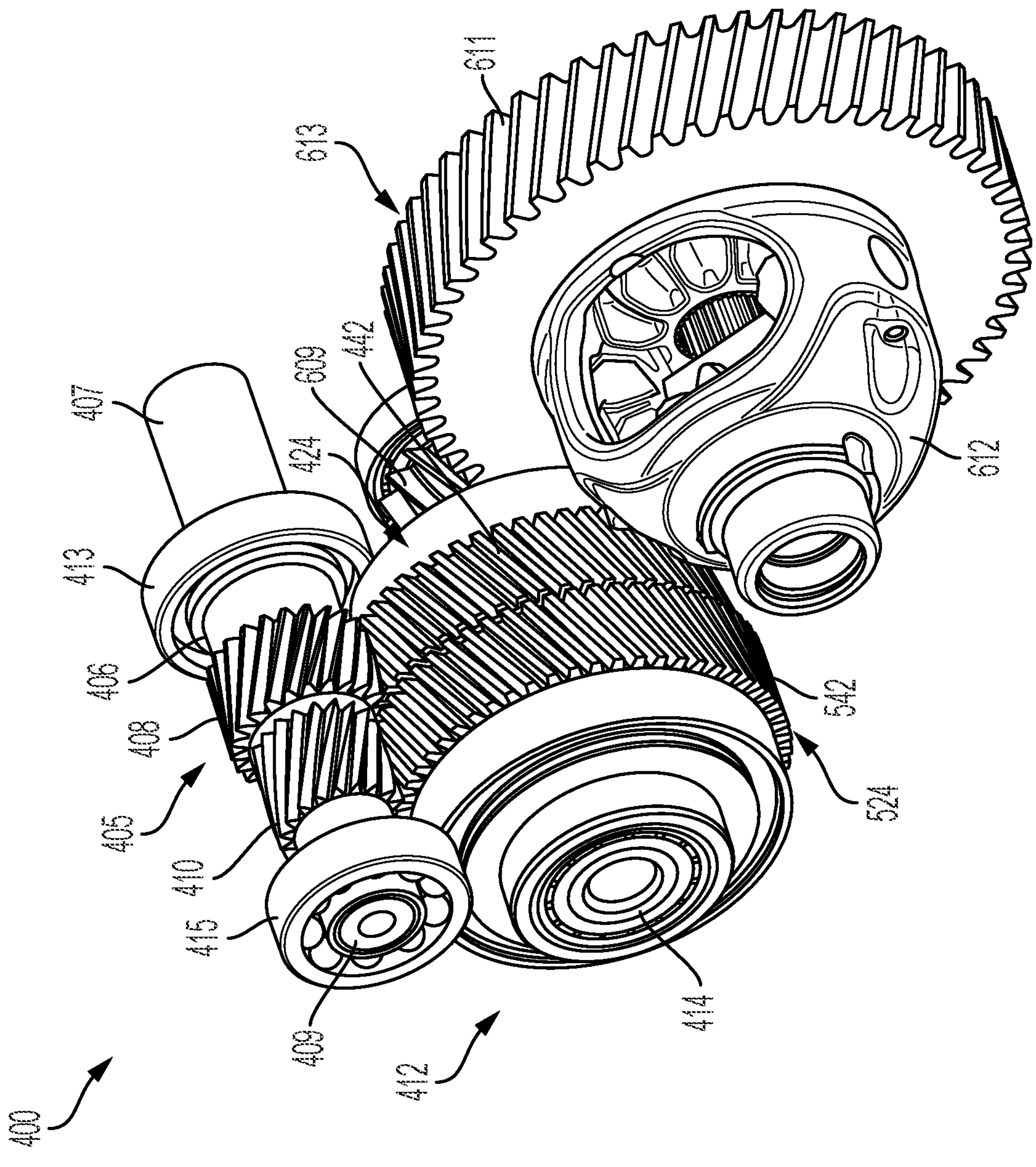

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FIG. 11

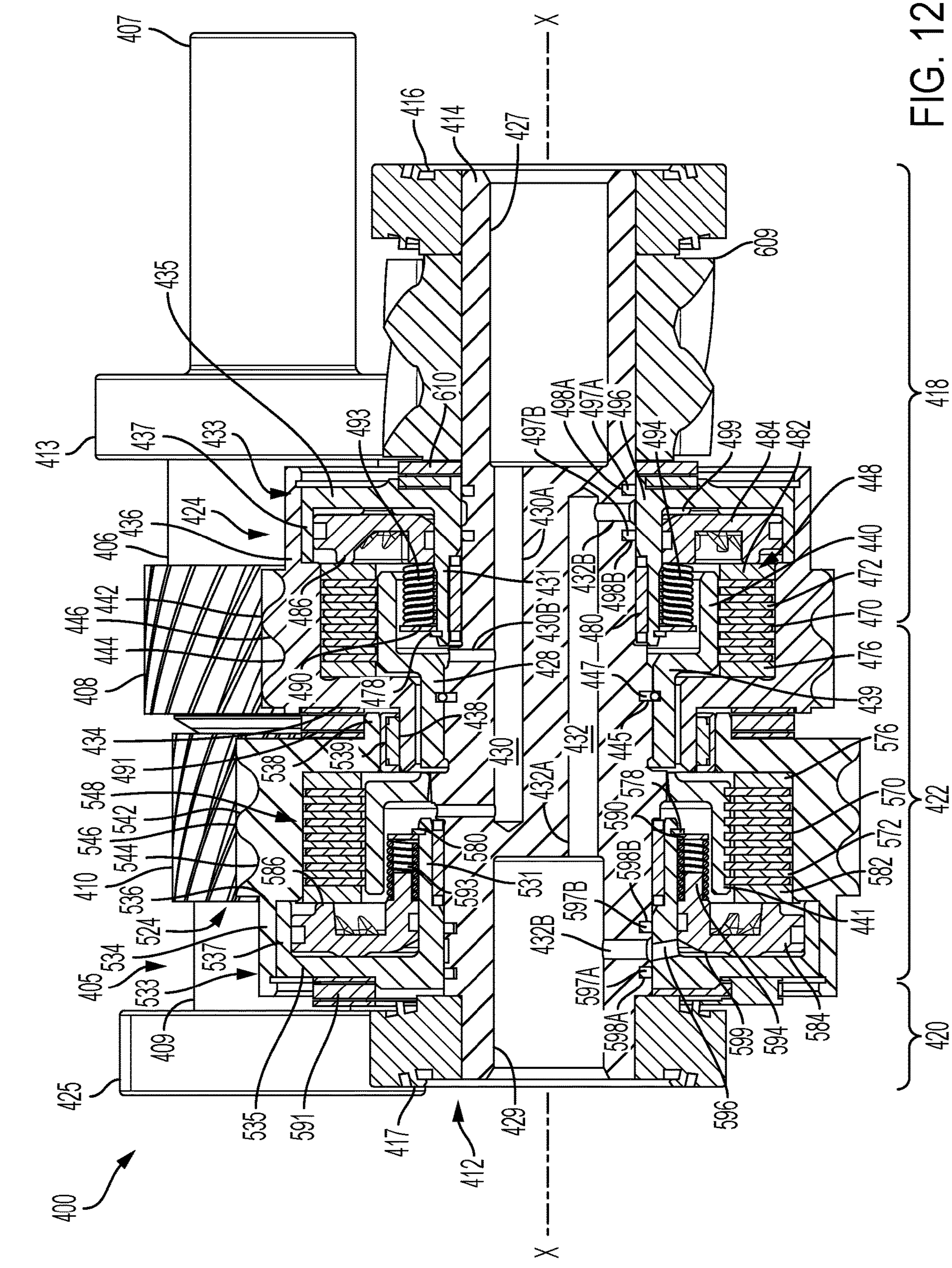

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FIG. 12

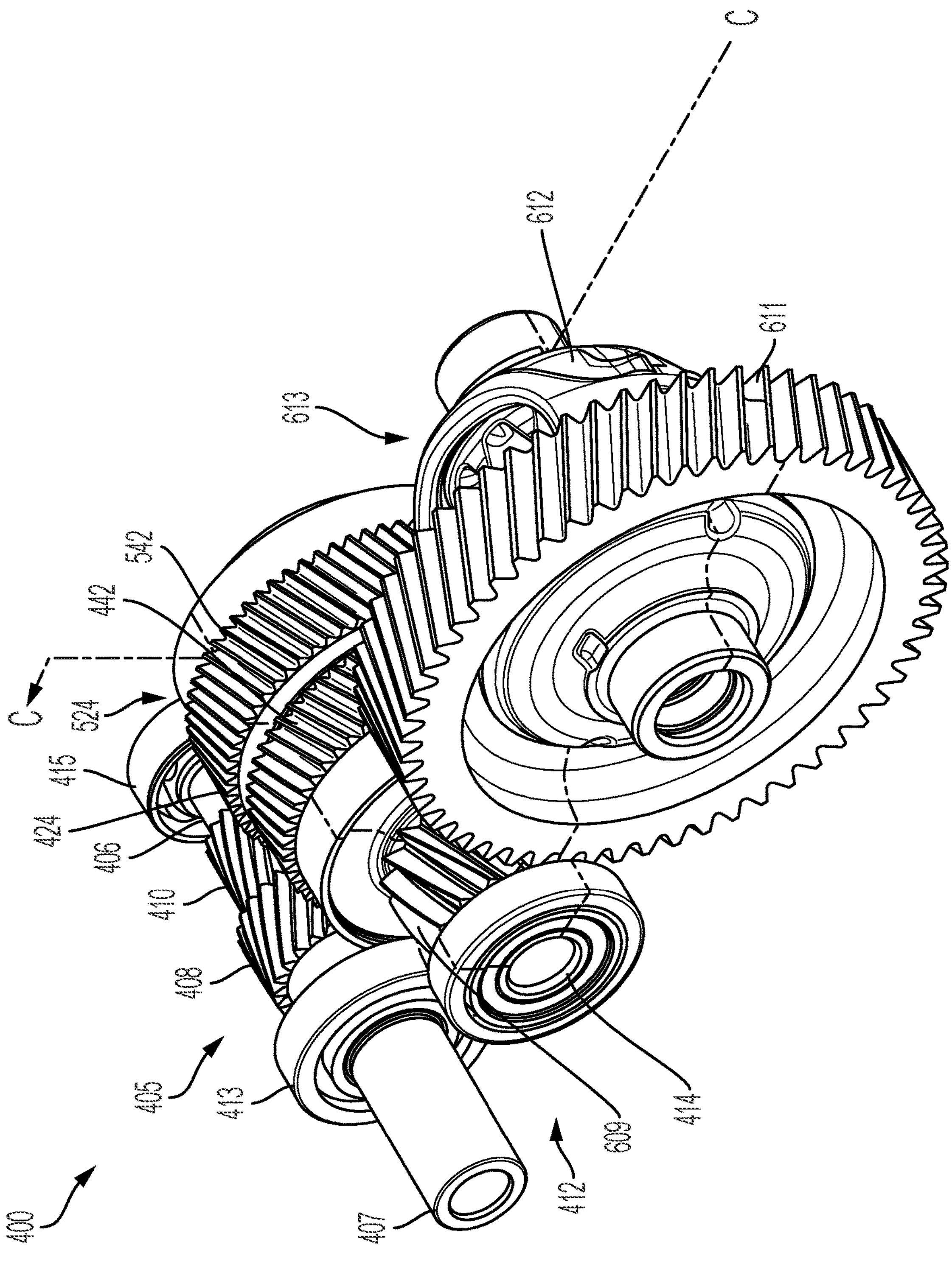
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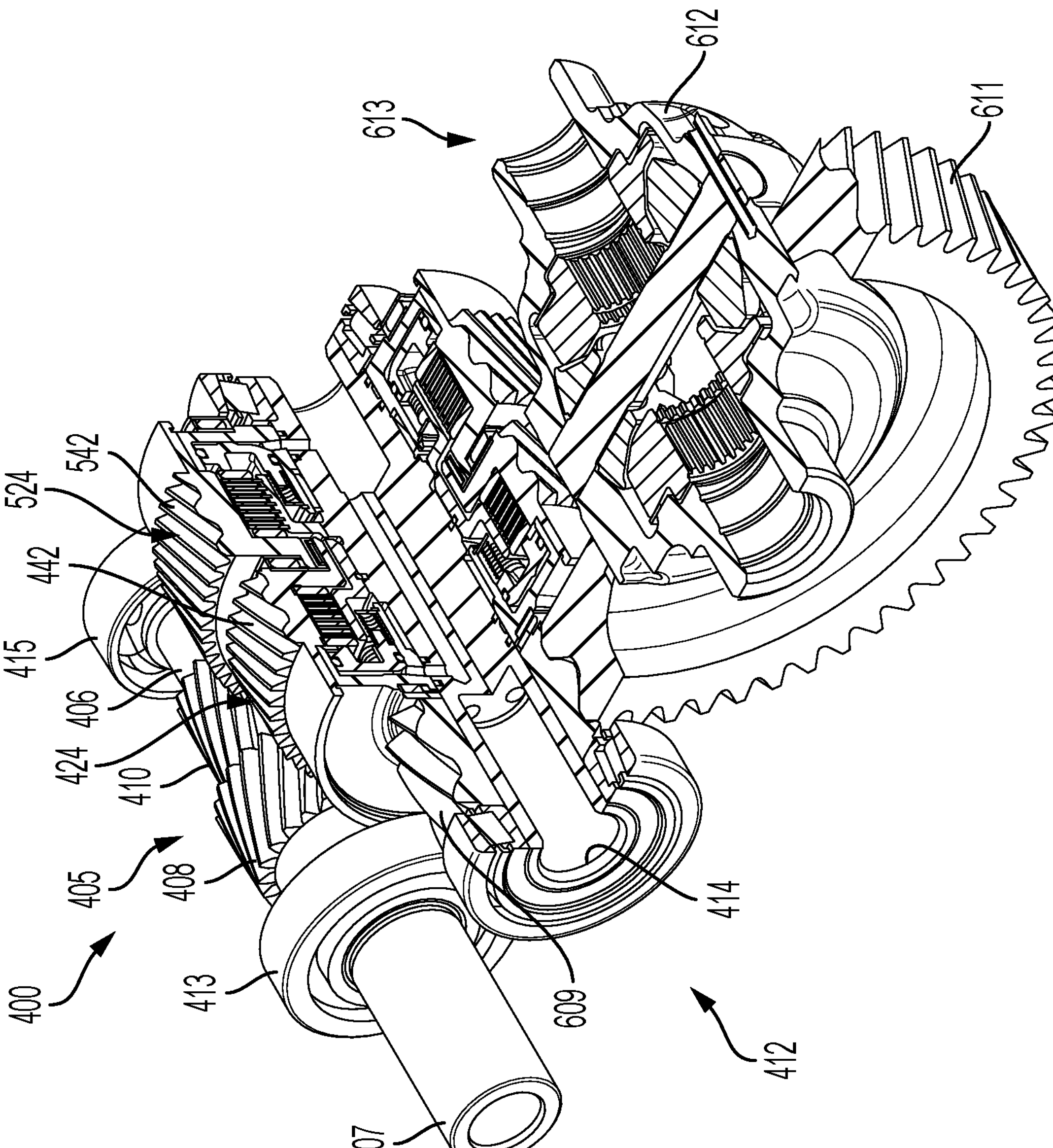
FIG. 13



SECTION C-C
FIG. 14

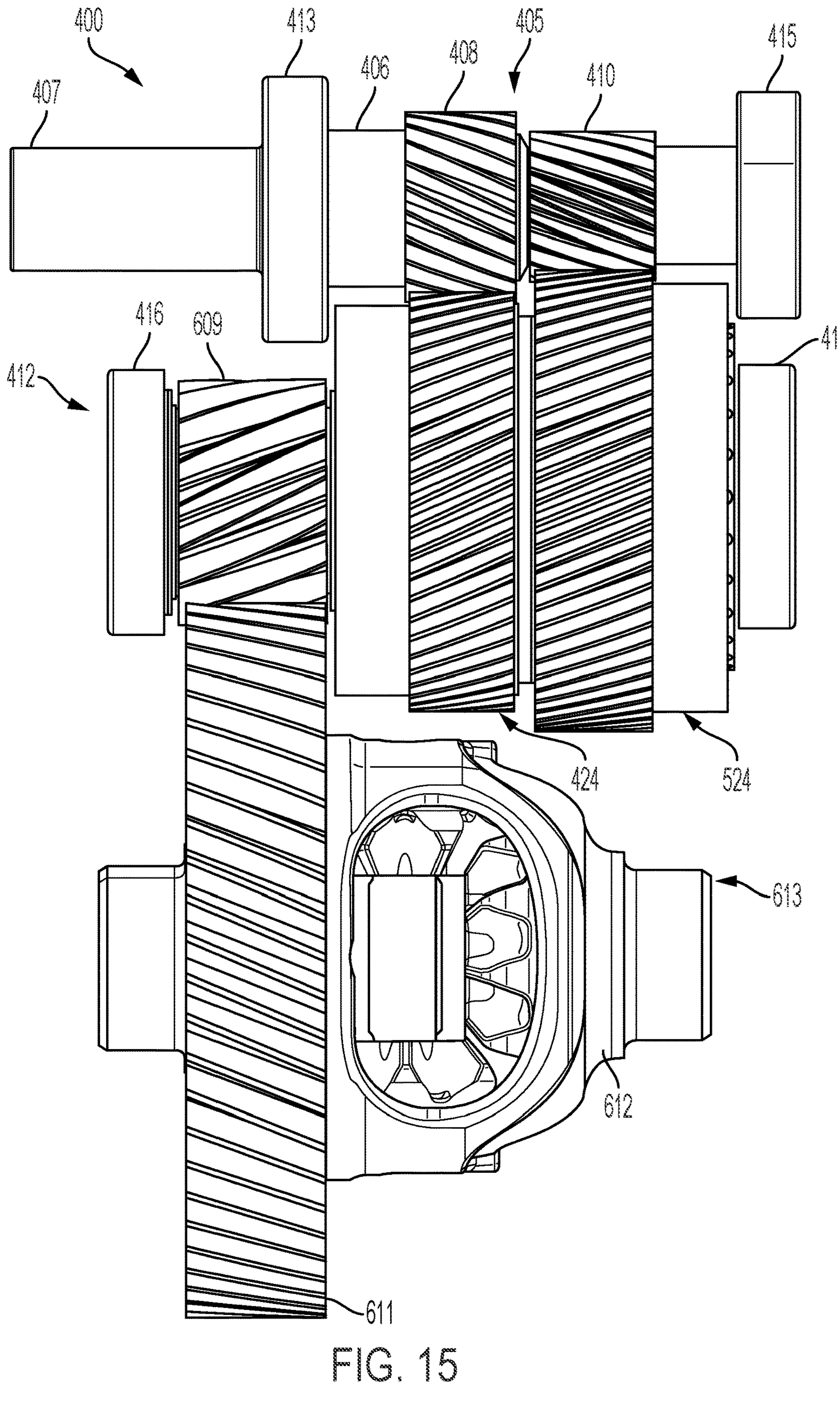

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FIG. 15

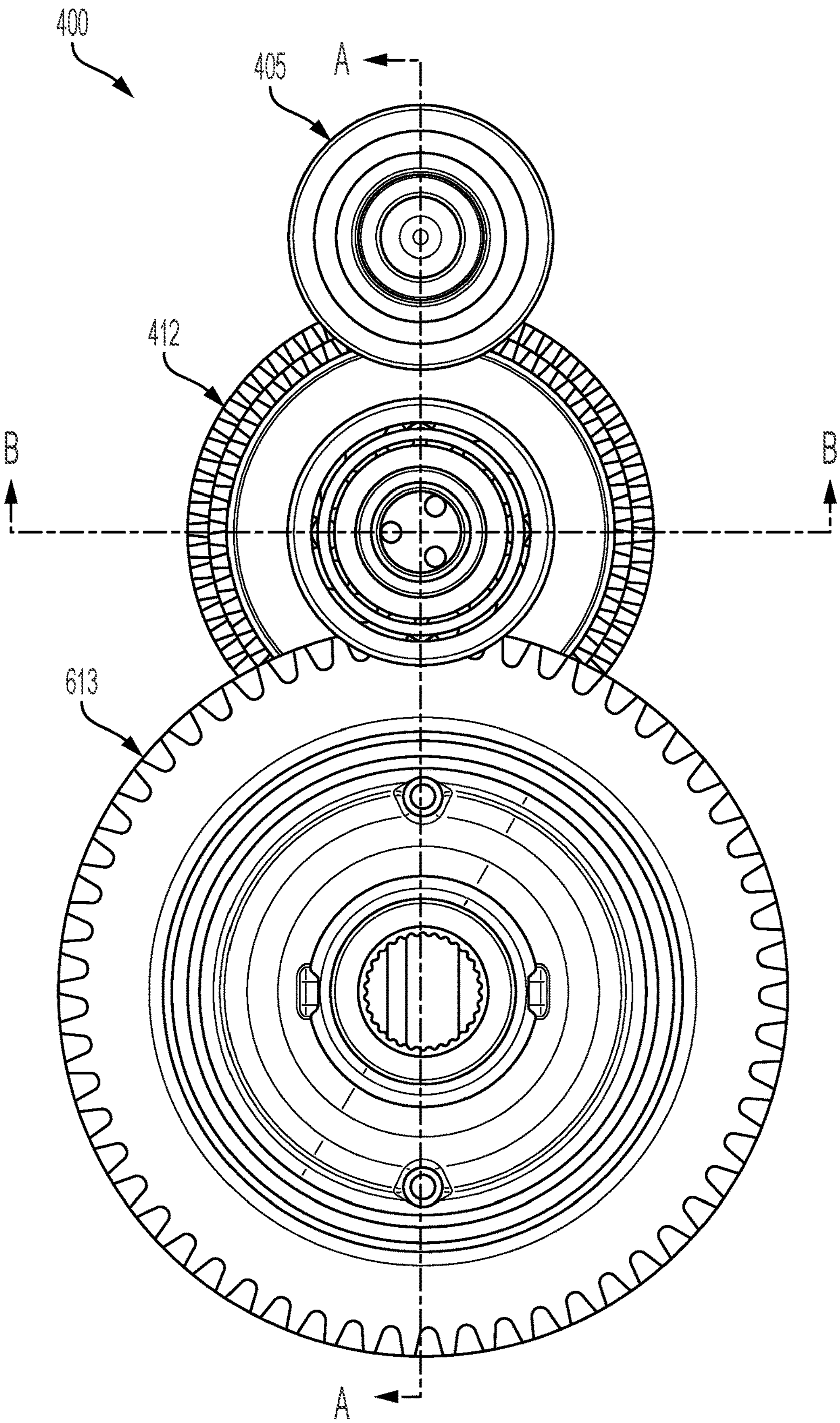
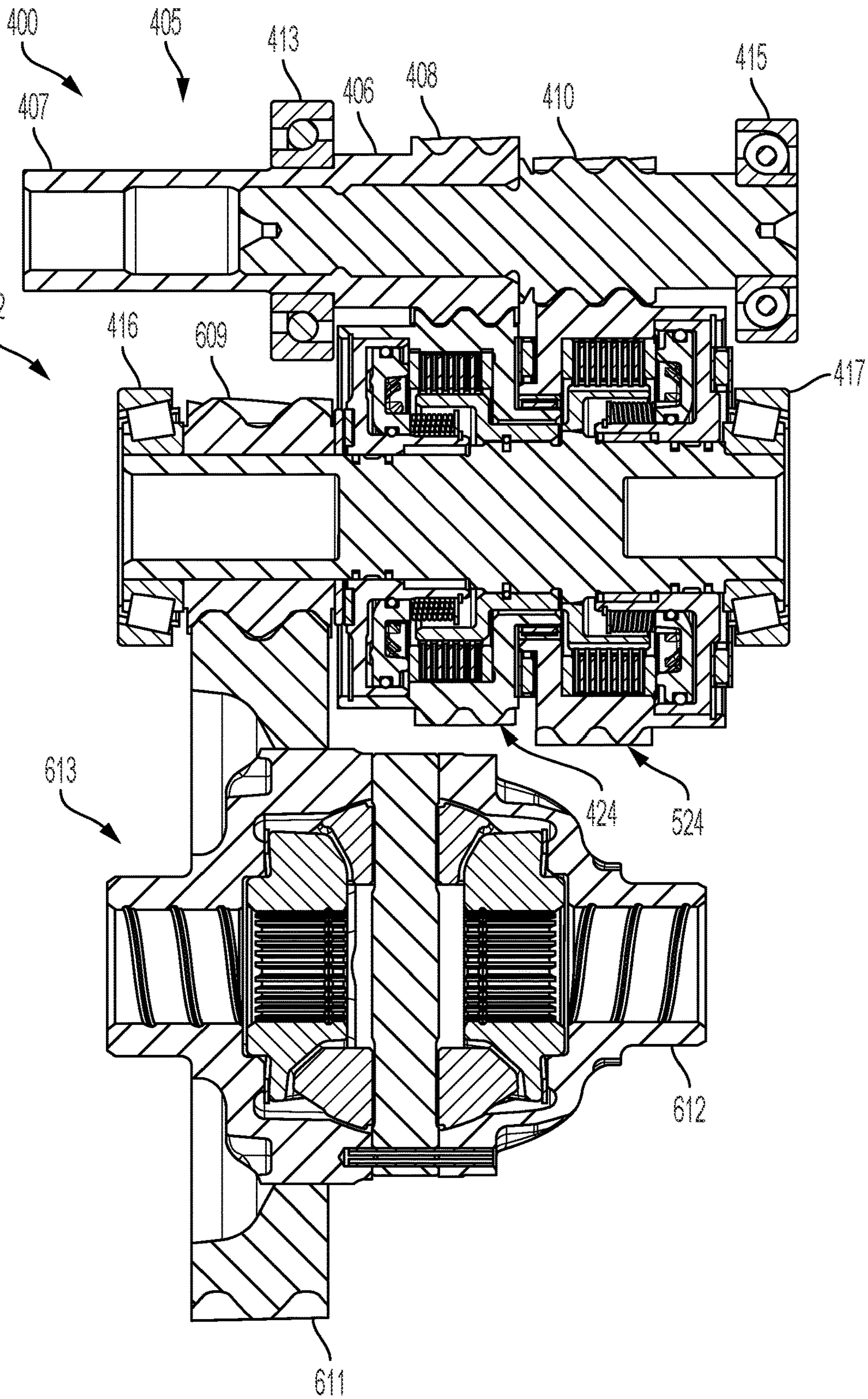
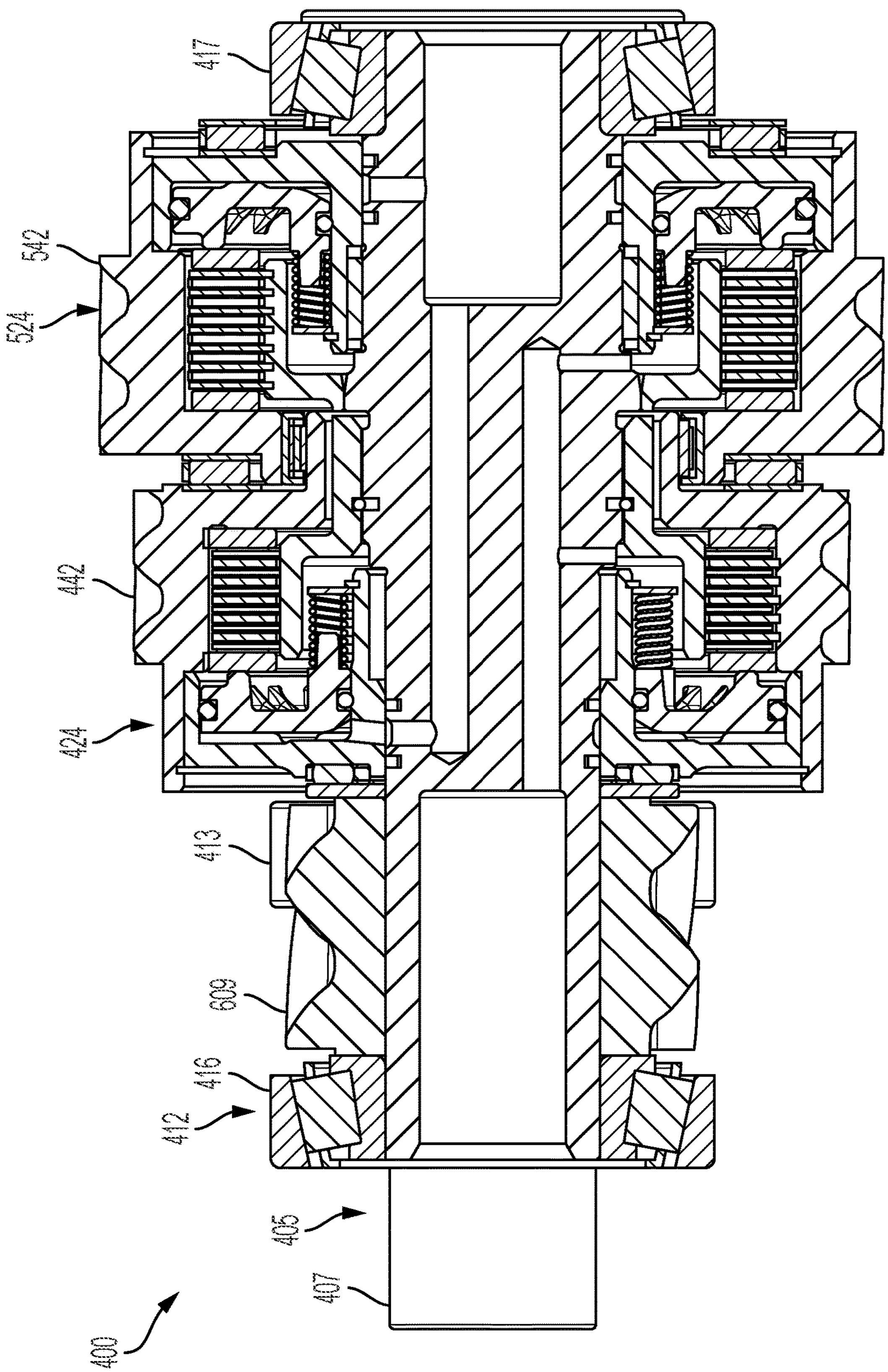


FIG. 16



SECTION A-A

FIG. 17



SECTION B-B
FIG. 18

MULTI-SPEED GEARBOX WITH A GEAR-CLUTCH ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a divisional of U.S. Non-Provisional patent application Ser. No. 16/820,589, entitled "MULTI-SPEED GEARBOX WITH A GEAR-CLUTCH ASSEMBLY", and filed on Mar. 16, 2020. U.S. application Ser. No. 16/820,589 claims priority to U.S. Provisional Application No. 62/818,492, entitled "Multi-Speed Gearbox with a Gear-Clutch Assembly", and filed on Mar. 14, 2019. The entire contents of the above-listed application are hereby incorporated by reference for all purposes.

TECHNICAL FIELD

The present disclosure relates to electric drive axles, and more particularly to a multi-speed gearbox for an electric drive axle.

BACKGROUND AND SUMMARY

Electric and hybrid-electric vehicles utilize an electric power source in communication with an electric motor to provide drive, or augmented drive, to the vehicle. Electric vehicles have several characteristics superior to conventional internal combustion engine driven vehicles. For example, electric motors produce fewer vibrations than internal combustion engines, and electric motors achieve maximum torque more quickly than internal combustion engines.

However, in order for the conventional electric vehicle to achieve sufficient speed, the electric motor must allow for reasonable power over a broad speed range. An electric motor which can provide reasonable power over a broad speed range is typically large and heavy. It would be desirable to produce an electric drive axle having a gear arrangement, at least one clutch assembly, and differential which generates a plurality of gear ratios, and yet remains compact in size and weight.

In concordance and agreement with the present disclosure, an electric drive axle having a gear arrangement, at least one clutch assembly, and differential which generates a plurality of gear ratios, and yet remains compact in size and weight, has surprisingly been discovered.

The present disclosure provides for an electric drive axle for a vehicle. In one embodiment, the electric drive axle of the vehicle comprises an electric motor having an output shaft. A compound idler assembly is connected to the electric motor. The compound idler assembly includes at least one gear-clutch assembly in driving engagement with the output shaft of the electric motor. A differential is connected to the compound idler assembly, and in selective driving engagement with the compound idler assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are incorporated herein as part of the specification. The drawings described herein illustrate embodiments of the presently disclosed subject matter, and are illustrative of selected principles and teachings of the present disclosure. However, the drawings do not illustrate all possible implementations of the presently disclosed subject matter, and are not intended to limit the scope of the present disclosure in any way.

FIG. **1** is a schematic diagram of a vehicle driveline according to an embodiment of the presently disclosed subject matter;

FIG. **2** is a side perspective view of a portion of an electric drive axle of the vehicle driveline shown in FIG. **1** according to one embodiment, including a motor output assembly, a compound idler assembly, and a differential;

FIG. **3** is a side perspective view of the portion of the electric drive axle shown in FIG. **2**, wherein a quarter-section of the compound idler assembly has been removed;

FIG. **4** is a plan view of the portion of the electric drive axle shown in FIGS. **2-3**;

FIG. **5** is a front elevational view of the portion of the electric drive axle shown in FIGS. **2-4**;

FIG. **6** is a side elevational view of the portion of the electric drive axle shown in FIGS. **2-4**;

FIG. **7** is a side elevational view of the portion of the electric drive axle shown in FIGS. **2-5**;

FIG. **8** is a cross-sectional view taken along section line B-B detailed in FIG. **6** of the portion of the electric drive axle shown in FIGS. **2-7**;

FIG. **9** is a cross-sectional view taken along section line C-C detailed in FIG. **6** of the portion of the electric drive axle shown in FIGS. **2-7**;

FIG. **10** is a cross-sectional view taken along section line D-D detailed in FIG. **6** of the portion of the electric drive axle shown in FIGS. **2-7**;

FIG. **11** is side perspective of a portion of an electric drive axle of the vehicle driveline shown in FIG. **1** according to yet another embodiment of the presently disclosed subject matter, including a motor output assembly, a compound idler assembly, and a differential;

FIG. **12** is a front elevational view of the portion of the electric drive axle shown in FIG. **11**, wherein the compound idler assembly is shown in section and the differential has been removed; and

FIG. **13** is an opposite side perspective view of the portion of the electric drive axle of the vehicle driveline shown in FIGS. **11-12**;

FIG. **14** is a side perspective view of the portion of the electric drive axle shown in FIG. **13**, wherein a quarter-section of the compound idler assembly and a half-section of the differential has been removed;

FIG. **15** is a plan view of the portion of the electric drive axle shown in FIGS. **11-14**;

FIG. **16** is a side elevational view of the portion of the electric drive axle shown in FIGS. **11-15**;

FIG. **17** is a cross-sectional view taken along section line A-A detailed in FIG. **16** of the portion of the electric drive axle shown in FIGS. **11-16**; and

FIG. **18** is a cross-sectional view taken along section line B-B detailed in FIG. **16** of the portion of the electric drive axle shown in FIGS. **11-17**.

DETAILED DESCRIPTION

It is to be understood that the invention may assume various alternative orientations and step sequences, except where expressly specified to the contrary.

It is also to be understood that the specific assemblies and systems illustrated in the attached drawings, and described in the following specification are simply exemplary embodiments of the inventive concepts defined herein. Hence, specific dimensions, directions or other physical characteristics relating to the embodiments disclosed are not to be considered as limiting, unless expressly stated otherwise. Also, although they may not be, like elements in various embodiments described herein may be commonly referred to with like reference numerals within this section of the application.

Embodiments of an electric drive axle are described below. In certain embodiments, the electric drive axles **100**, **400** are utilized with a pure electric vehicle (not depicted) where the electric drive axles **100**, **400** are the only driving axle. In other embodiments, as illustrated in FIG. **1**, the electric drive axles **100**, **400** are utilized with a hybrid four-wheel-drive vehicle **10** where the front axle is driven by an internal combustion engine **12**, and the rear axle is one of the electric drive axles **100**, **400** (or vice versa). In still other embodiments, the electric drive axles **100**, **400** are utilized in a hybrid commercial vehicle (not depicted) comprising a tandem axle in which the front tandem axle is driven by an internal combustion engine, and the rear tandem axle is one of the electric drive axles **100**, **400** (or vice versa). In certain embodiments, each of the electric drive axles **100**, **400** includes a first half axle **16** and a second half axle **18**, each of which is coupled to a wheel assembly of the vehicle **10**. The electric drive axles **100**, **400** may have applications in commercial vehicles, both light duty and heavy duty vehicles, and for passenger, off-highway, and sport utility vehicles. Additionally, the electric drive axles **100**, **400** described herein may be adapted for use in front and/or rear driving axles, and in steerable and non-steerable axles. It would be understood by one of ordinary skill in the art that the electric drive axles **100**, **400** also have industrial, locomotive, military, agricultural, and aerospace applications.

The electric drive axles **100**, **400** may also comprise an integrated drive system. As shown in FIG. **1**, each of the electric drive axles **100**, **400** includes an electric motor **104** (e.g., electromotor) coupled with a power source (not depicted). The electric motor **104** may be a permanent magnet synchronous machine comprising a stator disposed concentrically about a rotor. Each of the electric drive axles **100**, **400** may additionally comprise an inverter (not depicted) for converting direct current to alternating current when the electric motor **104** is utilized to drive the vehicle, and for converting alternating current to direct current when the vehicle decelerates. The electric motor **104** may be referred to herein as a motor-generator. Further, the electric drive axles **100**, **400** may include cooling fluid (not depicted such as, but not limited to, automatic transmission fluid or axle oil) integrated with the electric drive axle **100**, **400** lubricant for cooling the electric motor **104** and the inverter. In another embodiment (not depicted), the cooling fluid for the electric motor **104** and the inverter may not be integrated with the axle oil. The electric drive axle **100**, **400** may have either a co-axial or off-axis layout (as shown) where the axle shaft connecting the wheel to the differential does not pass through the center or the motor but rather parallel to the motor axis.

Referring now to FIGS. **2-10**, a motor output assembly **105** having a motor output shaft **106** is coupled with the rotor of the electric motor **104** for rotation therewith. A first end **107** of the motor output shaft **106** may include a plurality of splines (not depicted) to facilitate coupling to the electric motor **104**. It should be appreciated, however, that the motor output assembly **105** can be coupled to the electric motor **104** by various other coupling methods, if desired. In certain embodiments, the motor output shaft **106** has a generally uniform diameter extending from the first end **107** to an opposite second end **109**. Yet, in other embodiments, the motor output shaft **106** may be tapered having a gradually increasing diameter from the first end **107** to the second end **109**.

A first gear **108** and a second gear **110** may be coupled with the motor output shaft **106** for rotation therewith. As shown, the first gear **108** is disposed axially adjacent the first end **107** and the second gear **110** is disposed axially adjacent the second end **109**. In an embodiment, the first and second gears **108**, **110** are forged on the motor output shaft **106**. In another embodiment, the first and second gears **108**, **110** may be welded to the motor output shaft **106**. In still another embodiment, the first and second gears **108**, **110** may be splined to the motor output shaft **106**. First and second bearings **113**, **115**, respectively, may also be disposed axially adjacent the first end **107** and the second end **109**, respectively, to rotatably support the motor output assembly **106** in a housing (not depicted) such as an axle housing (not shown), for example. Various types of bearings **113**, **115** such as a roller bearing, a ball bearing, a tapered bearing, and the like, for example, may be employed.

In certain embodiments, the electric motor **104** drives a compound idler assembly **112** via the motor output shaft **106** and the first and second gears **108**, **110**. As shown, the motor output assembly **105**, the compound idler assembly **112**, and axle half shafts **16**, **18** are disposed offset and parallel relative to one another. It is understood, however, that the motor output assembly **105**, the compound idler assembly **112**, and the axle half shafts **16**, **18** may be disposed co-axially relative to one another. The compound idler assembly **112** includes an idler shaft **114** rotatably supported in a housing (not depicted) such as an axle housing, for example. As more clearly shown in FIGS. **8-10**, the idler shaft **114** has an outer first segment **118**, an outer second segment **120**, and an intermediate third segment **122** interposed axially between the first and second segments **118**, **120**. The first and second segments **118**, **120** form opposing ends of the idler shaft **114**. In certain embodiments, a diameter of the first segment **118** is substantially equivalent to a diameter of the second segment **120**. A diameter of the third segment **122** shown is greater than the diameters of the segments **118**, **120**. It is understood, however, that the diameter of each of the segments **118**, **120**, **122** may be any diameter as desired. As more clearly shown in FIGS. **8-10**, each of the segments **118**, **120** may include a cavity **127**, **129**, respectively, formed therein.

Each of the segments **118**, **120**, shown in FIG. **10**, may also include first and second fluid passages **130**, **132**, respectively, formed therein. In one embodiment, the first and second fluid passages **130**, **132** are in fluid communication with a first fluid source (not depicted) and configured to receive a first fluid (not depicted) therethrough. Various types of fluid can be used for the first fluid as desired such as a lubricant or cooling fluid, for example. The first and second fluid passages **130**, **132** may be formed substantially perpendicular to the longitudinal axis X-X of the idler shaft **114** extending radially outward to an outer peripheral surface of the idler shaft **114**. It should be appreciated that any number of the fluid passages **130**, **132** may be formed in the idler shaft **114** if desired.

A first gear-clutch assembly **124** is disposed concentrically about the first segment **118** of the idler shaft **114**. The first gear-clutch assembly **124** is in meshed engagement with the first gear **108** of the output shaft **106** of the electric motor **104** and receives torque therefrom. As illustrated in FIGS. **8-10**, the first gear-clutch assembly **124** includes a housing **133** having a web portion **134** connecting a radially outer first annular hub **136**, a radially inner second annular hub **138**, and a third annular hub **140**. Both the first and second annular hubs **136**, **138** extend axially inward from the web portion **134** and the third annular hub **140** extends axially outward from the web portion **134**. A third gear **142** is formed on an outer surface **144** of the first annular hub **136**. The third gear **142** is disposed concentrically about at least a portion of the first segment **118** of the idler shaft **114**. As illustrated in FIGS. **2-7**, the third gear **142** is generally ring-shaped. In an embodiment shown in FIGS. **8-10**, the third gear **142** includes a plurality of teeth **146** extending radially outward from the outer surface **144** thereof.

As more clearly shown in FIGS. **8-10**, the second annular hub **138** is configured to be received into the cavity **127** formed in the first segment **118** of the idler shaft **114**. At least one bearing **147** may be disposed between the second annular hub **138** and an inner surface of the first segment **118**. In certain embodiments, a pair of needle bearings **147** is disposed therebetween. A bearing **116** may also be disposed on the third annular hub **140** to rotatably support the compound idler assembly **112** within a housing (not depicted) such as an axle housing, for example. It should be appreciated, however, that any number and type of bearings **116**, **147** may be employed as desired.

Referring now to FIGS. **3-10**, the first gear-clutch assembly **124** further includes a first clutch **148** therein. The first clutch **148** includes a first clutch drum **150** disposed at least partially concentrically within the first annular hub **136** and the third gear **142**. A plurality of splines (not depicted) is formed on an annular flange portion **154** of the first clutch drum **150**. The splines extending radially outward from an outer surface of the annular flange portion **154**. The annular flange portion **154** may also include at least one aperture **156** formed therethrough. As illustrated in FIG. **10**, a pair of apertures **156** is formed at various intervals about a circumference of the annular flange portion **154**. It is understood that any number of apertures **156** can be formed at any position in the first clutch drum **150** as desired. Each of the apertures **156** is in fluid communication with the first fluid passage **130** formed in the idler shaft **114** to receive the first fluid therethrough.

The first clutch drum **150** further includes an annular hub **160** formed concentrically within the annular flange portion **154**. In certain embodiments, an inner surface of the annular hub **160** includes a plurality of splines (not depicted) formed thereon. The splines of the annular hub **160** are configured to cooperate with the splines formed on the first segment **118** of the idler shaft **114** to couple the annular hub **160** thereto and transfer the torque from the first clutch drum **150** to the idler shaft **114**. In other embodiments, the first clutch drum **150** may be coupled to the idler shaft **114** by a press fit. In yet other embodiments, the first clutch drum **150** may be integrally formed with the idler shaft **114** as a unitary component. Accordingly, it should be appreciated that the first clutch drum **150** can be coupled to the idler shaft **114** by any suitable method as desired. The annular hub **160** may also include at least one aperture **157**, shown in FIG. **10**, formed therethrough. In certain embodiments, a plurality of apertures **157** may be formed at various intervals about a circumference of the annular hub **160**. It is understood that any number of apertures **157** can be formed at any position in the first clutch drum **150** as desired. Each of the apertures **157** is in fluid communication with the first fluid passage **130** formed in the idler shaft **114** and the aperture **156** formed in the annular flange portion **154**.

A web portion **166** is formed to extend between the annular flange portion **154** of the first clutch drum **150** and the annular hub **160**. The web portion **166** may include at least one aperture (not depicted) formed therethrough. In certain embodiments, a plurality of apertures may be formed at various intervals about a circumference of the web portion **166**. It is understood that any number of apertures can be formed at any position in the web portion **166** as desired. Each of the apertures may be in fluid communication with at least one of the first fluid passage **130** formed in the idler shaft **114** and the respective apertures **156**, **157** formed in the first clutch drum **150**. The apertures **156**, **157** and the first fluid passage **130** formed in the idler shaft **114** are fluidly connected to facilitate a flow of the first fluid from the first fluid source to the first clutch **148**. In certain embodiments, the flow of the first fluid from the fluid source provides at least one of lubrication and cooling to the first clutch **148** of the first gear-clutch assembly **124**.

As more clearly shown in FIGS. **8-10**, the first clutch **148** includes a plurality of first clutch plates **170** interleaved with a plurality of second clutch plates **172**. Each of the clutch plates **170**, **172** is concentrically disposed about the first clutch drum **150** and within the first annular hub **136** and the third gear **142**. The first clutch plates **170** are in meshed engagement with the first annular hub **136**. In certain embodiments, each of the first clutch plates **170** includes a plurality of splines (not depicted) extending radially outward therefrom. The splines of the first clutch plates **170** cooperate with a plurality of splines formed on an inner surface of the first annular hub **136**. As such, the first clutch plates **170** receive torque from the first annular hub **136** and the third gear **142**. The first clutch plates **170** may move axially relative to the first annular hub **136** and the third gear **142** within the first gear-clutch assembly **124**. The first clutch plates **170** transfer the torque from the first annular hub **135** and the third gear **142** to the second clutch plates **172**. It is understood that the first clutch plates **170** can be coupled to the first annular hub **136**, while permitting an axial movement thereof, by any suitable method as desired.

In one embodiment, the second clutch plates **172** are in meshed engagement with the first clutch drum **150**. In certain embodiments, each of the second clutch plates **172** includes a plurality of splines (not depicted) extending radially inward therefrom. The splines of the second clutch plates **172** cooperate with the splines formed on the outer surface of the annular flange portion **154** of the first clutch drum **150**. As such, the second clutch plates **172** receive the torque from the first clutch plates **170**. The second clutch plates **172** may move axially relative to the first annular hub **136** and the third gear **142** within the first gear-clutch assembly **124**. The second clutch plates **172** transfer the torque from the first clutch plates **170** to the first clutch drum **150**, and thereby the idler shaft **114**. It is understood that the second clutch plates **172** can be coupled to the first clutch drum **150**, while permitting an axial movement thereof, by any suitable method as desired.

A first support plate **176** is disposed at a first side of the first clutch **148** within the first annular hub **136** and the third gear **142**. The first support plate **176** is generally ring-shaped and concentrically disposed about the idler shaft **114** of the compound idler assembly **112**. The first support plate **176** performs as an abutment for the clutch plates **170**, **172** during engagement of the first clutch **148**. In certain embodiments, the first support plate **176** is configured to be received in an annular recess **178** formed in the inner surface of the first annular hub **136**. A positioning element **179** (e.g. a snap ring) may be disposed adjacent the first support plate **176** to maintain a position thereof. In certain embodiments, the positioning element **179** is received in an annular recess formed in the inner surface of the first annular hub **136**. At least one thrust element **183** may also be disposed adjacent at least one of the first support plate **176** and the positioning element **179** to provide a friction bearing surface. The first support plate **176** shown also includes an annular recess **181** formed therein. The annular recess **181** is configured to receive at least a portion of the annular flange portion **154** of the first clutch drum **150** therein.

As illustrated more clearly in FIG. **2**, at least one of the first annular hub **136** and the first support plate **176** may also include at least one aperture **185** formed therethrough. The at least one aperture **185** may be formed at various intervals about a circumference of the first annular hub **136** and the first support plate **176**. It is understood that any number of apertures **185** can be formed at any position in at least one of the first annular hub **136** and the first support plate **176** as desired. Each of the apertures **185** is in fluid communication with the first clutch **148** to facilitate a flow of the first fluid from the first clutch **148** into the housing (e.g. the axle housing).

In an embodiment shown, a bearing **180** is interposed between the first support plate **176** and the idler shaft **114**. Yet, in another embodiment, the bearing **180** is interposed between the first support plate **176** and the annular hub **160** of the first clutch drum **150**. The bearing **180** provides rotational support of the first support plate **176**. Various types of bearings **180** may be employed as desired. For example, the bearing **180** may be a needle bearing, a roller bearing, or a ball bearing.

As more clearly illustrated FIGS. **8-10**, a pressure plate **182** may be disposed at an opposite second side of the first clutch **148** within the first annular hub **136** and the third gear **142**. The pressure plate **182** is also generally ring-shaped and concentrically disposed about the idler shaft **114** of the compound idler assembly **112**. The pressure plate **182** includes a plurality of splines (not depicted) extending radially outward therefrom. The splines of the pressure plate **182** cooperate with the splines formed on the inner surface of the first annular hub **136**. The pressure plate **182** may move axially relative to the first annular hub **136** and the third gear **142** within the first gear-clutch assembly **124**. The pressure plate **182** is configured to urge the clutch plates **170**, **172** in a first axial direction towards the first support plate **176** during engagement of the first clutch **148**. It is understood that the pressure plate **182** can be coupled to the first annular hub **136**, while permitting an axial movement thereof, by any suitable method as desired.

As illustrated, a piston member **184** may also be concentrically disposed about the idler shaft **114** axially adjacent to the pressure plate **182**. The piston member **184** includes an axially extending annular portion **186**. The axially extending annular portion **186** protrudes towards the pressure plate **182** when assembled. The annular portion **186** of the piston member **184** abuts the pressure plate **182** and is configured to urge the pressure plate **182** in the first axial direction towards the first support plate **176** during engagement of the first clutch **148**.

In certain embodiments, the first gear-clutch assembly **124** further includes a second support plate **190**. The second support plate **190** is concentrically disposed about the second annular hub **138** axially adjacent to the first clutch drum **150**. At least one thrust element or bearing **191** may interposed between the second support plate **190** and at least one of the idler shaft **114** and the first clutch drum **150**. The at least one thrust element or bearing **191** provides rotational support of the second support plate **190**. Various types of thrust elements or bearings **191** may be employed as desired. The thrust element or bearing **191** is configured to militate against frictional contact between the second support plate **190** and the first segment **118** of the idler shaft **114**. In certain embodiments, the second support plate **190** may include an annular recess **192** formed therein. A biasing element **193** may be interposed between the piston member **184** and the second support plate **190**. A first end of the biasing element **193** is disposed within the annular recess **192** of the second support plate **190**. The biasing member **193** is configured to urge the piston member **184** in an opposite second axial direction during an operation of the first clutch **148**. The biasing member **193** may be concentrically disposed about the second annular hub **138** and axially between the piston member **184** and the second support plate **190**.

In certain embodiments, the web portion **134** may also include a third fluid passage **196** formed therein. The third fluid passage **196** is in fluid communication with a second fluid source (not depicted) and configured to receive a second fluid (not depicted) therethrough. Various types of second fluids from various second fluid sources can be used as desired such as a hydraulic fluid from a hydraulic manifold, for example. As shown, the third fluid passage **196** parallel to the longitudinal axis X-X of the idler shaft **114**. It should be appreciated that any number of third fluid passages **196** may be formed in the web portion **134** if desired. A pair of sealing members (not depicted) may be disposed on opposite sides of the third fluid passage **196** to militate against leakage therefrom. In certain embodiments, the sealing members may be disposed in a pair of grooves (not depicted) formed in the web portion **134**. It is understood that any number of sealing members may be employed if desired.

As shown, the third fluid passage **196** extends axially inward from an outer surface of the web portion **134** to a chamber **199** formed between the piston member **184** and the web portion **134**. In certain embodiments, an amount of the second fluid in the chamber **199** is varied to selectively position the piston member **184** for engagement and disengagement of the first clutch **148**. A first sealing member **200** is interposed between the piston member **184** and the inner surface of the first annular hub **136** and a second sealing member **202** is interposed between the piston member **184** and the second annular hub **138** to militate against leakage of the second fluid from the chamber **199** during operation of the first gear-clutch assembly **124**. It should be appreciated that the first and second sealing member **200**, **202** may be integrally formed as a unitary component if desired.

Similarly, a second gear-clutch assembly **224** is disposed concentrically about the second segment **120** of the idler shaft **114**. The second gear-clutch assembly **224** is in meshed engagement with the second gear **110** of the output shaft **106** of the electric motor **104** and receives torque therefrom. As illustrated in FIGS. **8-10**, the second gear-clutch assembly **224** includes a housing **226** having a web portion **227** connecting radially outer first annular hub **228**, a radially inner second annular hub **229**, and a third annular hub **230**. Both the first and second annular hubs **227**, **228** extend axially inward from the web portion **227** and the third annular hub **230** extends axially outward from the web portion **227**. A fourth gear **234** is formed on an outer surface **235** of the first annular hub **228**. The fourth gear **234** is disposed concentrically about at least a portion of the second segment **120** of the idler shaft **114**. As illustrated in FIGS. **2-7**, the fourth gear **234** is generally ring-shaped. In an embodiment shown in FIGS. **8-10**, the fourth gear **234** includes a plurality of teeth **236** extending radially outward from the outer surface **235** thereof.

As more clearly shown in FIGS. **8-10**, the second annular hub **138** is configured to be received into the cavity **129** formed in the second segment **120** of the idler shaft **114**. At least one bearing **231** may be disposed between the second annular hub **229** and an inner surface of the second segment **120**. In certain embodiments, a pair of needle bearings **231** is disposed therebetween. A bearing **117** may also be disposed on the third annular hub **230** to rotatably support the compound idler assembly **112** within a housing (not depicted) such as an axle housing, for example. It should be appreciated, however, that any number and type of bearings **117**, **231** may be employed as desired.

Referring now to FIGS. **3-10**, the second gear-clutch assembly **224** further includes a second clutch **248** therein. The second clutch **248** includes a second clutch drum **250** disposed at least partially concentrically within the first annular hub **228**. A plurality of splines (not depicted) is formed on an annular flange portion **254** of the second clutch drum **250** extending radially outward from an outer surface of the annular flange portion **254**. The annular flange portion **254** may also include at least one aperture **256** formed therethrough. As illustrated in FIG. **10**, a pair of the apertures **256** may be formed at various intervals about a circumference of the annular flange portion **254**. It is understood that any number of the apertures **256** may be formed at any position in the second clutch drum **250** as desired. Each of the apertures **256** may be in fluid communication with the second fluid passage **132** formed in the idler shaft **114** to receive the first fluid therethrough.

The second clutch drum **250** further includes an annular hub **260** formed concentrically within the annular flange portion **254**. In certain embodiments, an inner surface of the annular hub **260** includes a plurality of splines (not depicted) formed thereon. The splines of the annular hub **260** are configured to cooperate with the splines formed on the second segment **120** of the idler shaft **114** to couple the annular hub **260** thereto and transfer the torque from the second clutch drum **250** to the idler shaft **114**. In other embodiments, the second clutch drum **250** may be coupled to the idler shaft **114** by a press fit. In yet other embodiments, the second clutch drum **250** may be integrally formed with the idler shaft **114** as a unitary component. Accordingly, it should be appreciated that the second clutch drum **250** can be coupled to the idler shaft **114** by any suitable method as desired. The annular hub **260** may also include at least one aperture **265**, shown in FIG. **10**, formed therethrough. In certain embodiments, a plurality of apertures **265** may be formed at various intervals about a circumference of the annular hub **260**. It is understood that any number of apertures **265** can be formed at any position in the second clutch drum **250** as desired. Each of the apertures **265** is in fluid communication with the second fluid passage **132** formed in the idler shaft **114** and the aperture **256** formed in the annular flange portion **254**.

A web portion **266** is formed to extend between the annular flange portion **254** of the second clutch drum **250** and the annular hub **260**. The web portion **266** may include at least one aperture (not depicted) formed therethrough. In certain embodiments, a plurality of the apertures may be formed at various intervals about a circumference of the web portion **266**. It is understood that any number of apertures can be formed at any position in the web portion **266** as desired. Each of the apertures may be in fluid communication with at least one of the second fluid passage **132** formed in the idler shaft **114** and the aperture **256** formed in the annular flange portion **254**. The apertures **256**, **265** and the second fluid passage **132** are fluidly connected to facilitate a flow of the first fluid from the first fluid source to the second clutch **248**. In certain embodiments, the flow of the first fluid from the first fluid source provides at least one of lubrication and cooling to the second clutch **248** of the second gear-clutch assembly **224**.

As more clearly shown in FIG. **8-10**, the second clutch **248** includes a plurality of first clutch plates **270** interleaved with a plurality of second clutch plates **272**. Each of the clutch plates **270**, **272** is concentrically disposed about the second clutch hub **250** and within the first annular hub **228** and the fourth gear **234**. The first clutch plates **270** are in meshed engagement with the first annular hub **228**. In certain embodiments, each of the first clutch plates **270** includes a plurality of splines (not depicted) extending radially outward therefrom. The splines of the first clutch plates **270** cooperate with a plurality of splines (not depicted) formed on an inner surface of the first annular hub **228**. As such, the first clutch plates **270** receive torque from the first annular hub **228** and the fourth gear **234**. The first clutch plates **270** may move axially relative to the first annular hub **228** and the fourth gear **234** within the second gear-clutch assembly **224**. The first clutch plates **270** transfer the torque from the first annular hub **228** and the fourth gear **234** to the second clutch plates **272**. It is understood that the first clutch plates **270** can be coupled to the first annular hub **228**, while permitting an axial movement thereof, by any suitable method as desired.

In an embodiment, the second clutch plates **272** are in meshed engagement with the second clutch hub **250**. In certain embodiments, each of the second clutch plates **272** includes a plurality of splines (not depicted) extending radially inward therefrom. The splines of the second clutch plates **272** cooperate with the splines formed on the outer surface of the annular flange portion **254** of the second clutch drum **250**. As such, the second clutch plates **272** receive the torque from the first clutch plates **270**. The second clutch plates **272** may move axially relative to the first annular hub **228** and the fourth gear **234** within the second gear-clutch assembly **224**. The second clutch plates **272** transfer the torque from the first clutch plates **270** to the second clutch drum **250**, and thereby the idler shaft **114**. It is understood that the second clutch plates **272** can be coupled to the second clutch drum **250**, while permitting an axial movement thereof, by any suitable method as desired.

A first support plate **276** is disposed at a first side of the second clutch **248** within the first annular hub **228** and the fourth gear **234**. The first support plate **276** is generally ring-shaped and concentrically disposed about the idler shaft **114** of the compound idler assembly **112**. The first support plate **276** performs as an abutment for the clutch plates **270**, **272** during engagement of the second clutch **248**. In certain embodiments, the first support plate **276** is configured to be received in an annular recess **277** formed in the inner surface of the first annular hub **228**. A positioning element **278** (e.g. a snap ring) may be disposed adjacent the first support plate **276** to maintain a position thereof. In certain embodiments, the positioning element **278** is received in an annular recess formed in the inner surface of the first annular hub **228**. At least one thrust element **283** may also be disposed adjacent at least one of the first support plate **276** and the positioning element **278** to provide a friction bearing surface. The first support plate **276** shown also includes an annular recess **281** formed therein. The annular recess **281** is configured to receive at least a portion of the annular flange portion **254** of the second clutch drum **250** therein.

As illustrated more clearly in FIG. **2**, at least one of the first annular hub **228** and the first support plate **276** may also include at least one aperture **185** formed therethrough. The at least one aperture **285** may be formed at various intervals about a circumference of the first annular hub **228** and the first support plate **276**. It is understood that any number of apertures **285** can be formed at any position in at least one of the first annular hub **228** and the first support plate **276** as desired. Each of the apertures **285** is in fluid communication with the second clutch **248** to facilitate a flow of the first fluid from the second clutch **248** into the housing (e.g. the axle housing).

In an embodiment shown, a bearing **280** is interposed between the first support plate **276** and the idler shaft **114**. Yet, in another embodiment, the bearing **280** is interposed between the first support plate **276** and the annular hub **260** of the first clutch drum **250**. The bearing **280** provides rotational support of the first support plate **276**. Various types of bearing **280** may be employed as desired. For example, the bearing **280** may be a needle bearing, a roller bearing, or a ball bearing.

As more clearly illustrated FIGS. **8-10**, a pressure plate **282** may be disposed at an opposite second side of the second clutch **248** within the first annular hub **228** and the fourth gear **234**. The pressure plate **282** is also generally ring-shaped and concentrically disposed about the idler shaft **114** of the compound idler assembly **112**. The pressure plate **282** includes a plurality of splines (not depicted) extending radially outward therefrom. The splines of the pressure plate **282** cooperate with the splines formed on the inner surface of the first annular hub **228**. The pressure plate **282** may move axially relative to the first annular hub **228** and the fourth gear **234** within the second gear-clutch assembly **224**. The pressure plate **282** is configured to urge the clutch plates **270**, **272** in the second axial direction towards the first support plate **276** during engagement of the second clutch **248**. It is understood that the pressure plate **282** can be coupled to the first annular hub **228**, while permitting an axial movement thereof, by any suitable method as desired.

As illustrated, a piston member **284** may also be concentrically disposed about the idler shaft **114** axially adjacent to the pressure plate **282**. The piston member **284** includes an axially extending annular portion **286**. The axially extending annular portion **286** protrudes towards the pressure plate **282** when assembled. The annular portion **286** of the piston member **284** abuts the pressure plate **282** and is configured to urge the pressure plate **282** in the second axial direction towards the first support plate **276** during engagement of the second clutch **248**.

In certain embodiments, the second gear-clutch assembly **224** further includes a second support plate **290**. The second support plate **290** is concentrically disposed about the second annular hub **229** axially adjacent to the second clutch drum **250**. At least one thrust element or bearing **291** may interposed between the second support plate **290** and at least one of the idler shaft **114** and the second clutch drum **250**. The at least one thrust element or bearing **291** provides rotational support of the second support plate **290**. Various types of thrust element or bearings **291** may be employed as desired. The thrust element or bearing **291** is configured to militate against frictional contact between the second support plate **290** and the second segment **120** of the idler shaft **114**. In certain embodiments, the second support plate **290** may include an annular recess **292** formed therein. A biasing element **293** may be interposed between the piston member **284** and the second support plate **290**. A first end of the biasing element **293** is disposed within the annular recess **292** of the second support plate **290**. The biasing member **293** is configured to urge the piston member **284** in an opposite second axial direction during an operation of the second clutch **248**. The biasing member **293** may be concentrically disposed about the second annular hub **229** and axially between the piston member **284** and the second support plate **290**.

In certain embodiments, the web portion **227** may also include a fourth fluid passage **296** formed therein. The fourth fluid passage **296** is in fluid communication with a third fluid source (not depicted) and configured to receive a third fluid (not depicted) therethrough. Various types of third fluids from various third fluid sources can be used as desired such as a hydraulic fluid from a hydraulic manifold, for example. Similar to the third fluid passage **196** of the first gear-clutch assembly **14**, the fourth fluid passage **296** may be formed parallel to the longitudinal axis X-X of the idler shaft **114**. It should be appreciated that any number of fourth fluid passages **296** may be formed in the web portion **227** if desired. A pair of sealing members (not depicted) may be disposed on opposite sides of the fourth fluid passage **296** to militate against leakage therefrom. In certain embodiments, the sealing members may be disposed in a pair of grooves (not depicted) formed in the web portion **227**. It is understood that any number of sealing members may be employed if desired.

As shown, the fourth fluid passage **296** extends axially inward from an outer surface of the web portion **227** to a chamber **299** formed between the piston member **284** and the web portion **227**. In certain embodiments, an amount of the third fluid in the chamber **299** is varied to selectively position the piston member **284** for engagement and disengagement of the second clutch **248**. A first sealing member **300** is interposed between the piston member **284** and the inner surface of the first annular hub **136** and a second sealing member **302** is interposed between the piston member **284** and the second annular hub **229** to militate against leakage of the third fluid from the chamber **299** during operation of the second gear-clutch assembly **224**.

As illustrated in FIGS. **2-10**, a fifth gear **309** is disposed concentrically about and coupled with the third segment **122** of the idler shaft **114**. In an embodiment, the fifth gear **309** may be forged on the idler shaft **114**. The fifth gear **309** is in meshed engagement with a sixth gear **311**. As illustrated in FIG. **2-10**, the sixth gear **311** is coupled to, and fixed for rotation with, a differential case **310** of a differential **312**. The differential case **310** is rotatably supported within a housing (not depicted) such as the axle housing, via a pair of bearings (not depicted). It should be appreciated that any type of bearing can be employed such as a needle bearing, a roller bearing, a tapered bearing, and the like, for example.

As shown in FIGS. **8** and **10**, the differential **312** further includes two or more differential pinions **318**. The differential pinions **318** are coupled within the differential case **310** via a pinion shaft **320** (i.e., spider shaft). In an embodiment, the pinion shaft **320** may comprise a cross member. The differential pinions **318** are in meshed engagement with a first side gear **322** and a second side gear **324**. The first side gear **322** is coupled for rotation with the first axle shaft **16**, and the second side gear **324** is coupled for rotation with the second axle shaft **18**.

Additionally, the electric drive axle **100** may comprise a fluid actuator assembly (not depicted) such as a hydraulic actuator assembly, for example. The fluid actuator assembly can be in fluid communication with the second and third fluid sources and at least one of the first and second gear-clutch assemblies **124**, **224**. The fluid actuator assembly utilizes pressurized second and third fluid to actuate the first and second piston members **184**, **284** and thereby engage the first and second gear-clutch assemblies **124**, **224**, respectively.

Referring now to FIGS. **11-18**, an electric drive axle **400** according to another embodiment of the present disclosure is shown. The electric drive axle **400** includes a motor output assembly **405** having a motor output shaft **406** is coupled with the rotor of the electric motor **104** for rotation therewith. A first end **407** of the motor output shaft **406** may include a plurality of splines (not depicted) to facilitate coupling to the electric motor **104**. It should be appreciated, however, that the motor output assembly **405** can be coupled to the electric motor **104** by various other coupling methods, if desired. The motor output shaft **406** has a first end portion formed adjacent the first end **407**, a second end portion formed adjacent an opposite second end **409**, and an intermediate portion formed between the end portions and the first and second ends **407**, **409**. In the embodiment shown, a diameter of the intermediate portion has a larger diameter than a diameter of each of the end portions of the motor output shaft **406**. In certain other embodiments, the motor output shaft **406** has a generally uniform diameter extending from the first end **407** to the second end **409**. Yet, in another embodiment, the motor output shaft **406** may be tapered having a gradually increasing diameter from the first end **407** to the second end **409**.

A first gear **408** and a second gear **410** may be coupled with the motor output shaft **406** for rotation therewith. As shown, the first gear **408** is disposed axially adjacent the second gear **410**. The first and second gears **408**, **410** are disposed intermediate the first and second ends **407**, **409**, respectively, of the motor output shaft **406**. In an embodiment, the first and second gears **408**, **410** are forged on the motor output shaft **406**. In another embodiment, the first and second gears **408**, **410** may be welded to the motor output shaft **406**. In still another embodiment, the first and second gears **408**, **410** may be splined to the motor output shaft **406**. First and second bearings **413**, **415**, respectively, may also be disposed axially adjacent the first end **407** and the second end **409**, respectively, to rotatably support the motor output assembly **406** in a housing (not depicted) such as an axle housing (not shown), for example. Various types of bearings **413**, **415** such as a roller bearing, a ball bearing, a tapered bearing, and the like, for example, may be employed.

The electric drive axle **400** further includes a compound idler assembly **412**, which is driven by the electric motor **104** via the motor output shaft **406** and the first and second gears **408**, **410**. As shown, the motor output assembly **405**, the compound idler assembly **412**, and a differential **612** configured to receive the axle half shafts **16**, **18** are disposed offset and parallel relative to one another. It is understood, however, that the motor output assembly **405**, the compound idler assembly **412**, and the differential **312** for receiving the axle half shafts **16**, **18** may be disposed co-axially relative to one another.

The compound idler assembly **412** includes an idler shaft **414** rotatably supported in a housing (not depicted) such as an axle housing, for example. As more clearly shown in FIG. **12**, the idler shaft **414** has an outer first segment **418**, an outer second segment **420**, and an intermediate third segment **422** interposed axially between the first and second segments **418**, **420**. The first and second segments **418**, **420** form opposing ends of the idler shaft **414**. In certain embodiments, a diameter of the first segment **418** is substantially equivalent to a diameter of the second segment **420**. A diameter of the third segment **422** shown is greater than the diameters of the segments **418**, **420**. It is understood, however, that the diameter of each of the segments **418**, **420**, **422** may be any diameter as desired. Each of the segments **418**, **420** may include a cavity **427**, **429**, respectively, formed therein.

In certain embodiments, a pair of bearings **416**, **417** may also be disposed on the first and second segments **418**, **420**, respectively, of the idler shaft **414** to rotatably support the compound idler assembly **412** within a housing (not depicted) such as an axle housing, for example. It should be appreciated, however, that any number and type of bearings **416**, **417** may be employed as desired.

A clutch member **428** is concentrically disposed about the idler shaft **414**. In certain embodiments, the clutch member **428** includes a first hub portion **440**, an opposite second hub portion **441**, and an intermediate portion **439** formed therebetween. As shown, the clutch member **428** is fixedly coupled to the idler shaft **414**. In one embodiment, the clutch member **428** is coupled to the idler shaft **414** by a splined engagement therebetween. In another embodiment, the clutch member **428** is fixedly coupled to the idler shaft **414** by other methods such as by a weld or a press fit, for example. In yet other embodiments, the clutch member **428** may be integrally formed with the idler shaft **414** as a unitary component. Accordingly, it should be appreciated that the clutch member **428** can be coupled to the idler shaft **414** by any suitable method as desired. A sealing member **447** may be disposed in an annular groove **445** formed in at least one of the clutch member **428** and the idler shaft **414**. The sealing member **447** forms a substantially fluid-tight seal between the clutch member **428** and idler shaft **414**.

The first and second segments **418**, **420** may also include first and second fluid passages **430**, **432**, respectively, formed therein. It should be appreciated that any number of the fluid passages **430**, **432** may be formed in the idler shaft **414** if desired.

In certain embodiments, the first fluid passage **430** includes at least one first fluid conduit **430**A formed parallel to the longitudinal axis X-X of the idler shaft **414** and extending axially from the cavity **427** through the idler shaft **414** to an intermediation portion thereof. The first fluid passage **430** shown further includes at least one second fluid conduit **435**B formed perpendicular to the longitudinal axis X-X of the idler shaft **414** and extending radially from the at least one first fluid conduit **435**A to an outer peripheral surface of the idler shaft **414**. In one embodiment, the first fluid passage **430** is in fluid communication with a first fluid source (not depicted) and configured to receive a first fluid (not depicted) therethrough. Various types of fluid can be used for the first fluid as desired such as a lubricant or cooling fluid, for example. The first fluid passage **430**, and more particularly the fluid conduits **430**A, **430**B, permit a flow of the first fluid from the first fluid source to within a first gear-clutch assembly **424** and a second gear-clutch assembly **524** to provide at least one of lubrication and cooling thereto. It should be appreciated that the first fluid passage **430** may be formed from any number, size, and shape of fluid conduits **430**A, **430**B as desired.

In certain embodiments, the first gear-clutch assembly **424** and the second gear-clutch assembly **524** each include a housing **433**, **533**, respectively, which may also include at least one aperture (not depicted) formed therethrough. The at least one aperture may be formed at various intervals through the housing **433** of the first gear-clutch assembly **424** and the housing **533** of the second gear-clutch assembly **524**. It is understood that any number of apertures can be formed at any position in the housings **433**, **533** as desired. The apertures are in fluid communication with the respective gear-clutch assemblies **424**, **524** to facilitate a flow of the first fluid from within the first gear-clutch assembly **424** and the second gear-clutch assembly **524** into the housing (e.g. the axle housing).

As illustrated, the second fluid passage **432** includes at least one first fluid conduit **432**A formed parallel to the longitudinal axis X-X of the idler shaft **414** and extending axially from the cavity **429** through the idler shaft **414** to an intermediation portion thereof. The second fluid passage **432** shown further includes at least one second fluid conduit **4328** formed perpendicular to the longitudinal axis X-X of the idler shaft **414** and extending radially from either the cavity **429** or the at least one first fluid conduit **432**A to an outer peripheral surface of the idler shaft **414**. In one embodiment, the second fluid passage **432** is in fluid communication with a second fluid source (not depicted) and configured to receive a second fluid (not depicted) therethrough. Various types of fluid can be used for the second fluid as desired such as a fluid from another vehicle component, for example. In one example, the second fluid is a hydraulic fluid from a hydraulic system of the vehicle. In another example, the second fluid is a cooling fluid from the engine motor **104**. The second fluid passage **432**, and more particularly the fluid conduits **432**A, **4328**, permit a flow of the second fluid from the second fluid source to within the first gear-clutch assembly **424** and the second gear-clutch assembly **524** to provide actuation thereof. It should be appreciated that the second fluid passage **432** may be formed from any number, size, and shape of fluid conduits **432**A, **4328** as desired.

The first gear-clutch assembly **424** is disposed concentrically about the idler shaft **414**. The first gear-clutch assembly **424** is in meshed engagement with the first gear **408** of the output shaft **406** of the electric motor **104** and receives torque therefrom. As illustrated in FIG. **12**, the first gear-clutch assembly **424** includes a housing **433** having a first portion **434** and a second portion **435**. The first portion **434** shown is formed by a radially outer first annular hub **436** and a radially inner second annular hub **438**. The first annular hub **436** extends axially outward and the second annular hub **438** extends axially inward. The second portion **435** shown is formed by a radially outer third annular hub **437** and radially inner fourth annular hub **431**. Both the third and fourth annular hubs **437**, **431** extend axially inward. In an embodiment shown, a bearing **480** is interposed between the fourth annular hub **431** and the idler shaft **414**. The bearing **480** provides rotational and radial support of the first gear-clutch assembly **424**. Various types of bearings **480** may be employed as desired. For example, the bearing **480** may be a needle bearing, a roller bearing, or a ball bearing.

A third gear **442** is formed on an outer surface **444** of the first annular hub **436**. The third gear **442** is disposed concentrically about the idler shaft **414**. The third gear **442** is generally ring-shaped. In an embodiment shown in FIGS. **11-12**, the third gear **442** includes a plurality of teeth **446** extending radially outward from the outer surface **444** thereof.

As more clearly shown in FIGS. **11-12**, the second annular hub **438** is configured to be disposed concentrically about the idler shaft **414**. The intermediate portion **439** of the clutch member **428** is disposed between the second annular hub **438** and an inner surface of the idler shaft **414**. As shown, the second annular hub **438** is configured to rotate freely about the intermediate portion **439** of the clutch member **428**. At least one bearing (not depicted) may be disposed between the second annular hub **438** and an outer surface of the intermediate portion **439** of the clutch member **428**. Various types of bearings may be employed such as a needle bearing, for example.

Referring now to FIG. **12**, the first gear-clutch assembly **424** further includes a first clutch **448** therein. The first clutch **448** includes the first portion **440** of the clutch member **428** and at least a portion of the first annular hub **436**. A plurality of splines (not depicted) may be formed on the clutch member **428**. The splines extend radially outward from an outer surface of the clutch member **428**. In certain embodiments, an inner surface of the portion of the first annular hub **436** also includes a plurality of splines (not depicted) formed thereon. The splines extend radially inward from an inner surface of the portion of the first annular hub **436** which forms the first clutch **448**.

The first clutch **448** further includes a plurality of first clutch plates **470** interleaved with a plurality of second clutch plates **472**. Each of the clutch plates **470**, **472** is concentrically disposed about the first portion **440** of the clutch member **428** and within the first annular hub **436**. The first clutch plates **470** are in meshed engagement with the first annular hub **436**. In certain embodiments, each of the first clutch plates **470** includes a plurality of splines (not depicted) extending radially outward therefrom. The splines of the first clutch plates **470** cooperate with a plurality of splines formed on an inner surface of the first annular hub **436**. As such, the first clutch plates **470** receive torque from the first annular hub **436** and the third gear **442**. The first clutch plates **470** may move axially relative to the first annular hub **436** and the clutch member **428** within the first gear-clutch assembly **424**. The first clutch plates **470** transfer the torque from the first annular hub **436** and the third gear **442** to the second clutch plates **472**. It is understood that the first clutch plates **470** can be coupled to the first annular hub **436**, while permitting an axial movement thereof, by any suitable method as desired.

In one embodiment, the second clutch plates **472** are in meshed engagement with the first portion **440** of the clutch member **428**. In certain embodiments, each of the second clutch plates **472** includes a plurality of splines (not depicted) extending radially inward therefrom. The splines of the second clutch plates **472** cooperate with a plurality of splines formed on an outer surface of the first portion **440** of the clutch member **428**. As such, the second clutch plates **472** receive the torque from the first clutch plates **470**. The second clutch plates **472** may move axially relative to the first annular hub **436** and the clutch member **428** within the first gear-clutch assembly **424**. The second clutch plates **472** transfer the torque from the first clutch plates **470** to the clutch member **428**, and thereby the idler shaft **414**. It is understood that the second clutch plates **472** can be coupled to the clutch member **428**, while permitting an axial movement thereof, by any suitable method as desired.

A first support plate **476** is disposed at a first side of the first clutch **448** adjacent the first portion **434** of the housing **433** of the first gear-clutch assembly **424**, and between the first annular hub **436** and the first portion **440** of the clutch member **428**. The first support plate **476** is generally ring-shaped and concentrically disposed about the idler shaft **414** of the compound idler assembly **412**. The first support plate **476** performs as an abutment for the clutch plates **470**, **472** during engagement of the first clutch **448**. A positioning element (not depicted) (e.g. a snap ring) may be disposed adjacent the first support plate **476** to maintain a position thereof. In certain embodiments, the positioning element may be received in an annular recess formed in one of the inner surface of the first annular hub **436** and the outer surface of the first portion **440** of the clutch member **428**. At least one thrust element (not depicted) may also be disposed adjacent at least one of the first support plate **476** and the positioning element to provide a friction bearing surface.

As more clearly illustrated FIG. **12**, a pressure plate **482** may be disposed at an opposite second side of the first clutch **448** between the first annular hub **436** and the first portion **440** of the clutch member **428**. The pressure plate **482** is also generally ring-shaped and concentrically disposed about the idler shaft **414** of the compound idler assembly **412**. The pressure plate **482** may include a plurality of first splines (not depicted) extending radially outward therefrom. The first splines of the pressure plate **482** cooperate with the splines formed on the inner surface of the first annular hub **436**. The pressure plate **482** may also include a plurality of second splines (not depicted) extending radially inward therefrom. The second splines of the pressure plate **482** cooperate with the splines formed on the outer surface of the first portion **440** of the clutch member **428**. The pressure plate **482** may move axially relative to the first annular hub **436** and the clutch member **428** within the first gear-clutch assembly **424**. The pressure plate **482** is configured to urge the clutch plates **470**, **472** in a first axial direction towards the first support plate **476** during engagement of the first clutch **448**. It is understood that the pressure plate **482** can be coupled to the first annular hub **436** and the clutch member **428**, while permitting an axial movement thereof, by any suitable method as desired.

As illustrated, a piston member **484** is disposed within the second portion **435** of the housing **433** of the first gear-clutch assembly **424**. The piston member **484** may also be concentrically disposed about the idler shaft **414** axially adjacent to the pressure plate **482**. The piston member **484** includes an axially extending annular portion **486**. The axially extending annular portion **486** protrudes towards the pressure plate **482** when assembled. The annular portion **486** of the piston member **484** abuts the pressure plate **482** and is configured to urge the pressure plate **482** in the first axial direction towards the first support plate **476** during engagement of the first clutch **448**.

In certain embodiments, the first gear-clutch assembly **424** further includes a second support plate **490**. The second support plate **490** is concentrically disposed about the fourth annular hub **431** axially adjacent to the piston member **484**. A positioning element **478** (e.g. a snap ring) may be disposed adjacent the second support plate **490** to maintain a position thereof. In certain embodiments, the positioning element **478** is received in an annular recess formed in an outer surface of the fourth annular hub **431**. In certain embodiments, the second support plate **490** may include an annular recess (not depicted) formed therein. A biasing element **493** may be interposed between the piston member **484** and the second support plate **490**. A first end of the biasing element **493** may be disposed within the annular recess of the second support plate **490**. A second end of the biasing element **493** may be received on a positioning member **494** formed on the piston member **484**. The biasing member **493** is configured to urge the piston member **484** in an opposite second axial direction during an operation of the first clutch **448**. The biasing member **493** may be concentrically disposed about the fourth annular hub **431** and axially between the piston member **484** and the second support plate **490**.

In certain embodiments, the second portion **435** of the housing **433** may also include a third fluid passage **496** formed therein. The third fluid passage **496** is in fluid communication with the second fluid source and configured to receive the flow of the second fluid therethrough. As shown, the third fluid passage **496** is formed perpendicular to the longitudinal axis X-X of the idler shaft **414** and in fluid communication with the fluid conduit **4328** of the second fluid passage **432**. It should be appreciated that any number of third fluid passages **496** may be formed in the second portion **435** of the housing **433** if desired. A pair of sealing members **497**A, **4978** may be disposed on opposite sides of the third fluid passage **496** to militate against leakage therefrom. In certain embodiments, the sealing members **497**A, **4978** may be disposed in a pair of grooves **498**A, **4988**, respectively, formed in the idler shaft **414**. It is understood that any number of sealing members **497**A, **4978** may be employed if desired.

As shown, the third fluid passage **496** extends radially outward from an inner peripheral surface of the second portion **435** of the housing **433** to a chamber **499** formed between the piston member **484** and the second portion **435** of the housing **433**. In certain embodiments, an amount of the second fluid in the chamber **499** is varied to selectively position the piston member **484** for engagement and disengagement of the first clutch **448**. At least one sealing member (not depicted) is interposed between the piston member **484** and the inner surface of the third annular hub **437** and at least one sealing member (not depicted) is interposed between the piston member **484** and the outer surface of the fourth annular hub **431** to militate against leakage of the second fluid from the chamber **499** during operation of the first gear-clutch assembly **424**.

As shown, the first gear-clutch assembly **424** is disposed adjacent the second gear-clutch assembly **524**. At least one thrust element or bearing **491** may interposed between the first and second gear-clutch assemblies **424**, **524**. Various types of thrust elements or bearings **491** may be employed as desired. The thrust element or bearing **491** is configured to militate against frictional contact between the first and second gear-clutch assemblies **424**, **524**. At least one thrust element or bearing **591** may interposed between the second gear-clutch assembly **524** and the bearing **417**. Various types of thrust elements or bearings **591** may be employed as desired. The thrust element or bearing **591** is configured to receive an axial load of the compound idler assembly **412** and provide a friction bearing surface.

Similar to the first gear-clutch assembly **424**, the second gear-clutch assembly **524** is disposed concentrically about the idler shaft **414**. The second gear-clutch assembly **524** is in meshed engagement with the second gear **410** of the output shaft **406** of the electric motor **104** and receives torque therefrom. As illustrated in FIG. **12**, the second gear-clutch assembly **524** includes a housing **533** having a first portion **534** and a second portion **535**. The first portion **534** shown is formed by a radially outer first annular hub **536** and a radially inner second annular hub **538**. The first annular hub **536** extends axially outward and the second annular hub **538** extends axially inward. The second portion **535** shown is formed by a radially outer third annular hub **537** and radially inner fourth annular hub **531**. Both the third and fourth annular hubs **537**, **531** extend axially inward. In an embodiment shown, a bearing **580** is interposed between the fourth annular hub **531** and the idler shaft **414**. The bearing **580** provides rotational support of the second gear-clutch assembly **524**. Various types of bearings **580** may be employed as desired. For example, the bearing **580** may be a needle bearing, a roller bearing, or a ball bearing.

A fourth gear **542** is formed on an outer surface **544** of the first annular hub **536**. The fourth gear **542** is disposed concentrically about the idler shaft **414**. The fourth gear **542** is generally ring-shaped. In an embodiment shown in FIGS.

11-12, the fourth gear **542** includes a plurality of teeth **546** extending radially outward from the outer surface **544** thereof.

As more clearly shown in FIG. **12**, the second annular hub **538** is configured to be disposed concentrically about the idler shaft **414**, the intermediate portion **439** of the clutch member **428**, and the second annular hub **438** of the first gear-clutch assembly **424**. As shown, the second annular hub **538** is configured to rotate freely about the second annular hub **438** of the first gear-clutch assembly **424**. At least one bearing **539** may be disposed between the second annular hub **538** and the second annular hub **438** of the first gear-clutch assembly **424**. The bearing **539** provides rotational and radial support to the first and second gear-clutch assemblies **424**, **524**. Various types of bearings may be employed such as a needle bearing, for example.

Referring now to FIG. **12**, the second gear-clutch assembly **524** further includes a second clutch **548** therein. The second clutch **548** includes the second portion **441** of the clutch member **428** and at least a portion of the first annular hub **536**. A plurality of splines (not depicted) may be formed on the clutch member **428**. The splines extend radially outward from an outer surface of the clutch member **428**. In certain embodiments, an inner surface of the portion of the first annular hub **536** also includes a plurality of splines (not depicted) formed thereon. The splines extend radially inward from an inner surface of the portion of the first annular hub **536** which forms the second clutch **548**.

The second clutch **548** further includes a plurality of first clutch plates **570** interleaved with a plurality of second clutch plates **572**. Each of the clutch plates **570**, **572** is concentrically disposed about the second portion **441** of the clutch member **428** and within the first annular hub **536**. The first clutch plates **570** are in meshed engagement with the first annular hub **536**. In certain embodiments, each of the first clutch plates **570** includes a plurality of splines (not depicted) extending radially outward therefrom. The splines of the first clutch plates **570** cooperate with a plurality of splines formed on an inner surface of the first annular hub **536**. As such, the first clutch plates **570** receive torque from the first annular hub **536** and the fourth gear **542**. The first clutch plates **570** may move axially relative to the first annular hub **536** and the clutch member **428** within the second gear-clutch assembly **524**. The first clutch plates **570** transfer the torque from the first annular hub **536** and the fourth gear **542** to the second clutch plates **572**. It is understood that the first clutch plates **570** can be coupled to the first annular hub **536**, while permitting an axial movement thereof, by any suitable method as desired.

In one embodiment, the second clutch plates **572** are in meshed engagement with the second portion **441** of the clutch member **428**. In certain embodiments, each of the second clutch plates **572** includes a plurality of splines (not depicted) extending radially inward therefrom. The splines of the second clutch plates **572** cooperate with a plurality of splines formed on an outer surface of the second portion **441** of the clutch member **428**. As such, the second clutch plates **572** receive the torque from the first clutch plates **570**. The second clutch plates **572** may move axially relative to the first annular hub **536** and the clutch member **428** within the second gear-clutch assembly **524**. The second clutch plates **572** transfer the torque from the first clutch plates **570** to the clutch member **428**, and thereby the idler shaft **414**. It is understood that the second clutch plates **572** can be coupled to the clutch member **428**, while permitting an axial movement thereof, by any suitable method as desired.

A first support plate **576** is disposed at a first side of the second clutch **548** adjacent the first portion **534** of the housing **533** of the second gear-clutch assembly **524**, and between the first annular hub **536** and the second portion **441** of the clutch member **428**. The first support plate **476** is generally ring-shaped and concentrically disposed about the idler shaft **414** of the compound idler assembly **412**. The first support plate **576** performs as an abutment for the clutch plates **570**, **572** during engagement of the second clutch **548**. A positioning element (not depicted) (e.g. a snap ring) may be disposed adjacent the first support plate **576** to maintain a position thereof. In certain embodiments, the positioning element may be received in an annular recess formed in one of the inner surface of the first annular hub **536** and the outer surface of the second portion **441** of the clutch member **428**. At least one thrust element (not depicted) may also be disposed adjacent at least one of the first support plate **576** and the positioning element to provide a friction bearing surface.

As more clearly illustrated FIG. **12**, a pressure plate **582** may be disposed at an opposite second side of the second clutch **548** between the first annular hub **536** and the second portion **441** of the clutch member **428**. The pressure plate **582** is also generally ring-shaped and concentrically disposed about the idler shaft **414** of the compound idler assembly **412**. The pressure plate **582** may include a plurality of first splines (not depicted) extending radially outward therefrom. The first splines of the pressure plate **582** cooperate with the splines formed on the inner surface of the first annular hub **536**. The pressure plate **582** may also include a plurality of second splines (not depicted) extending radially inward therefrom. The second splines of the pressure plate **582** cooperate with the splines formed on the outer surface of the second portion **441** of the clutch member **428**. The pressure plate **582** may move axially relative to the first annular hub **536** and the clutch member **428** within the second gear-clutch assembly **524**. The pressure plate **582** is configured to urge the clutch plates **570**, **572** in the second axial direction towards the first support plate **576** during engagement of the second clutch **548**. It is understood that the pressure plate **582** can be coupled to the first annular hub **536** and the clutch member **428**, while permitting an axial movement thereof, by any suitable method as desired.

As illustrated, a piston member **584** is disposed within the second portion **535** of the housing **533** of the second gear-clutch assembly **524**. The piston member **584** may also be concentrically disposed about the idler shaft **414** axially adjacent to the pressure plate **582**. The piston member **584** includes an axially extending annular portion **586**. The axially extending annular portion **586** protrudes towards the pressure plate **582** when assembled. The annular portion **586** of the piston member **584** abuts the pressure plate **582** and is configured to urge the pressure plate **582** in the second axial direction towards the first support plate **576** during engagement of the second clutch **548**.

In certain embodiments, the second gear-clutch assembly **524** further includes a second support plate **590**. The second support plate **590** is concentrically disposed about the fourth annular hub **531** axially adjacent to the piston member **584**. A positioning element **578** (e.g. a snap ring) may be disposed adjacent the second support plate **590** to maintain a position thereof. In certain embodiments, the positioning element **578** is received in an annular recess formed in an outer surface of the fourth annular hub **531**. In certain embodiments, the second support plate **590** may include an annular recess (not depicted) formed therein. A biasing element **593** may be interposed between the piston member **584** and the second support plate **590**. A first end of the biasing element **593** may be disposed within the annular recess of the second support plate **590**. A second end of the biasing element **593** may be received on a positioning member **594** formed on the piston member **584**. The biasing member **593** is configured to urge the piston member **584** in the first axial direction during an operation of the second clutch **548**. The biasing member **593** may be concentrically disposed about the fourth annular hub **531** and axially between the piston member **584** and the second support plate **590**.

In certain embodiments, the second portion **535** of the housing **533** may also include a fourth fluid passage **596** formed therein. The fourth fluid passage **596** is in fluid communication with the second fluid source and configured to receive the flow of the second fluid therethrough. As shown, the fourth fluid passage **596** is formed perpendicular to the longitudinal axis X-X of the idler shaft **414** and in fluid communication with the fluid conduit **4328** of the second fluid passage **432**. It should be appreciated that any number of fourth fluid passages **596** may be formed in the second portion **535** of the housing **533** if desired. A pair of sealing members **597**A, **5978** may be disposed on opposite sides of the fourth fluid passage **596** to militate against leakage therefrom. In certain embodiments, the sealing members **597**A, **5978** may be disposed in a pair of grooves **598**A, **5988**, respectively, formed in the idler shaft **414**. It is understood that any number of sealing members **597**A, **5978** may be employed if desired.

As shown, the fourth fluid passage **596** extends radially outward from an inner peripheral surface of the second portion **535** of the housing **533** to a chamber **599** formed between the piston member **584** and the second portion **535** of the housing **533**. In certain embodiments, an amount of the second fluid in the chamber **599** is varied to selectively position the piston member **584** for engagement and disengagement of the second clutch **548**. At least one sealing member (not depicted) is interposed between the piston member **584** and the inner surface of the third annular hub **537** and at least one sealing member (not depicted) is interposed between the piston member **584** and the outer surface of the fourth annular hub **531** to militate against leakage of the second fluid from the chamber **599** during operation of the second gear-clutch assembly **524**.

As illustrated, a fifth gear **609** is disposed concentrically about and coupled with the first segment **418** of the idler shaft **414**. In an embodiment, the fifth gear **609** may be forged on the idler shaft **414**. In the embodiment shown, the fifth gear **609** is disposed adjacent the first gear-clutch assembly **424** and the bear **416**. At least one thrust element or bearing **610** may interposed between the first gear-clutch assembly **424** and the fifth gear **609**. Various types of thrust elements or bearings **610** may be employed as desired. The thrust element or bearing **610** is configured to receive the axial load of the compound idler assembly **412** and provide a friction bearing surface.

The fifth gear **609** is in meshed engagement with a sixth gear **611**. As illustrated in FIG. **11**, the sixth gear **611** is coupled to, and fixed for rotation with, a differential case **612** of a differential **613**. The differential case **613** is rotatably supported within a housing (not depicted) such as the axle housing, via a pair of bearings (not depicted). It should be appreciated that any type of bearing can be employed such as a needle bearing, a roller bearing, a tapered bearing, and the like, for example.

It is understood that an operation of the electric drive axles **100**, **400** are substantially similar, and therefore, the operation of the electric drive axle **100** is only described hereinafter.

In operation, when a first torque is desired, the fluid actuator assembly is activated. The fluid actuator assembly causes the second fluid to flow from the second fluid source through the third fluid passage **196** into the chamber **199**, thereby causing the piston member **184** of the first gear-clutch assembly **124** to be urged in the first axial direction. A movement of the piston member **184** in the first axial direction causes the first clutch **148** to engage, while the second clutch **248** of the second gear-clutch assembly **224** remains disengaged. When the first gear-clutch assembly **124** is engaged, the output shaft **106** of the electric motor **104** causes the first gear **108** coupled thereto, to rotate therewith. A rotation of the first gear **108** drives the third gear **134**, and causes the idler shaft **114** and the fifth gear **309** coupled thereto, to rotate therewith. A rotation of the fifth gear **309** drives the sixth gear **311**, and causes the differential case **310** to rotate therewith. A rotation of the differential case **310** further causes the first and second half shafts **16**, **18** to rotate therewith. The rotation of the differential case **310** transfers the desired first torque from the output shaft **106** to the first and second axle shafts **16**, **18**. When the electric drive axle **100** is in a power generation mode, the torque transfer described above is reversed.

When operation of the vehicle **10** in the first torque is no longer desired, an operation of the fluid actuator assembly is deactivated. Accordingly, the second fluid flows from the chamber **199** through the third fluid passage **196** and returns to the second fluid source. As the second fluid flows from the chamber **199**, the biasing member **206** urges the piston member **184** of the first gear-clutch assembly **124** in the second axial direction. A movement of the piston member **184** in the second axial direction causes the first clutch **148** to disengage. As a result, the torque from the output shaft **106** is not transferred to the third gear **134** of the compound idler assembly **112**.

When a second torque is desired, the fluid actuator assembly causes piston member **284** of the second gear-clutch assembly **224** to be urged in the first axial direction. In certain embodiments, the second torque is greater than the first torque. A movement of the piston member **284** in the second axial direction causes the second clutch **248** to engage, while the first clutch **148** of the first gear-clutch assembly **124** remains disengaged. When the second gear-clutch assembly **224** is engaged, the output shaft **106** of the electric motor **104** causes the second gear **110** coupled thereto, to rotate therewith. A rotation of the second gear **110** drives the fourth gear **234**, and causes the idler shaft **114** and the fifth gear **309** coupled thereto, to rotate therewith. A rotation of the fifth gear **309** drives the sixth gear **311**, and causes the differential case **310** to rotate therewith. A rotation of the differential case **310** further causes the first and second half shafts **16**, **18** to rotate therewith. The rotation of the differential case **310** transfers the desired second torque from the output shaft **106** to the first and second axle shafts **16**, **18**. When the electric drive axle **100** is in a power generation mode, the torque transfer described above is reversed.

When operation of the vehicle **10** in the second torque is no longer desired, an operation of the fluid actuator assembly is deactivated. Accordingly, the third fluid flows from the chamber **299** through the fourth fluid passage **296** and returns to the third fluid source. As the third fluid flows from the chamber **299**, the biasing member **306** urges the piston member **284** of the second gear-clutch assembly **224** in the first axial direction. A movement of the piston member **284** in the first axial direction causes the second clutch **248** to disengage. As a result, the torque from the output shaft **106** is not transferred to the fourth gear **234** of the compound idler assembly **112**.

Only one of the first and second gear-clutch assemblies **124**, **224** is fully engaged at one time during vehicle operation. However, in a parking brake mode, both the first and second gear-clutch assemblies **124**, **224** may be engaged simultaneously. The first and second gear-clutch assemblies, **124**, **224** also act as support members of the gear train.

It should be appreciated that various types of differentials may be employed for the differentials **312**, **613** such as a locking differential and a torque vectoring dual clutch, for example.

While various embodiments have been described above, it should be understood that they have been presented by way of example, and not limitation. It will be apparent to persons skilled in the relevant arts that the disclosed subject matter may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The embodiments described above are therefore to be considered in all respects as illustrative, not restrictive.

The invention claimed is:

1. An electric drive axle, comprising:

an electric motor having an output shaft with a first end and a second end opposite the first end, wherein the first end is coupled to the electric motor; and

a compound idler assembly connected to the electric motor, the compound idler assembly including at least one gear_clutch assembly in driving engagement with the output shaft of the electric motor;

a first gear, wherein the first gear is axially adjacent the first end;

wherein the output shaft is configured to rotate the first gear therewith, wherein rotation of the first gear is configured to rotate a third gear, an idler shaft of the compound idler assembly, and a fifth gear coupled thereto, wherein the fifth gear is axially adjacent a first end of the idler shaft and the third gear is centrally located between the first end and a second end of the idler shaft, wherein rotation of the fifth gear is configured to rotate a differential case, and wherein two or more differential pinions are coupled within the differential case,

wherein a fluid actuator is configured to urge a first piston member of a first gear clutch assembly to move in a first axial direction to engage a first clutch while a second clutch remains disengaged when a first torque is desired,

wherein the first piston member is axially adjacent a pressure plate, and

wherein the first piston member is axially outboard from the pressure plate relative to the idler shaft of the compound idler assembly, the pressure plate configured to urge clutch plates of the first gear clutch assembly towards a first support plate during engagement of the first clutch.

2. The electric drive axle of claim **1**, wherein rotation of the fifth gear is configured to rotate the differential case via rotation of a sixth gear, and wherein rotation of the differential case is configured to transfer the first torque from the output shaft to first and second drive axles.

3. The electric drive axle of claim **1**, wherein a fluid passage is configured to flow a fluid to a chamber in which the first piston member is arranged via activation of the fluid actuator, and wherein a force of the fluid overcomes a force of a biasing member to urge the first piston member in the first axial direction.

4. The electric drive axle of claim **3**, wherein the fluid passage is configured to flow the fluid away from the chamber when the first torque is no longer desired via deactivation of the fluid actuator.

5. The electric drive axle of claim **4**, wherein the biasing member is configured to urge the first piston member of the first gear_clutch assembly in a second axial direction and causes the first clutch to disengage, and wherein torque from the output shaft is not transferred to the third gear of the compound idler assembly.

6. The electric drive axle of claim **1**, wherein the fluid actuator is activated and configured to flow fluid to a chamber in which a second piston member is arranged in response to a second torque being desired, and wherein the second torque is greater than the first torque.

7. The electric drive axle of claim **6**, wherein the second piston member is configured to move in a second axial direction in response to the second torque being desired, and wherein the second piston member is configured to engage the second clutch upon moving in the second axial direction while the first clutch is disengaged.

8. The electric drive axle of claim **7**, wherein the second clutch is configured to rotate the differential case via rotation of a fourth gear, the fifth gear, a sixth gear, and the idler shaft.

9. An electric drive axle, comprising:

an electric motor configured to drive a compound idler assembly via a motor output shaft and a first gear and a second gear, where a motor output assembly, the compound idler assembly, and a differential are configured to receive axle half shafts that are disposed offset and parallel relatively to one another; wherein

the differential is configured to selectively engage with the compound idler assembly in response to a position of a piston member of a first gear clutch assembly, the first gear clutch assembly comprising a first clutch, wherein the differential is engaged with the compound idler assembly and provides a first torque when the piston member is in a first position or a second torque when the piston member is in a second position, and wherein the differential is not engaged with the compound idler assembly when the piston member is in a third position between the first position and the second position, and

the piston member is axially adjacent a pressure plate, wherein the piston member is axially outboard from the pressure plate relative to an idler shaft of the compound idler assembly, the pressure plate configured to urge clutch plates of the first gear clutch assembly towards a first support plate during engagement of the first clutch.

10. The electric drive axle of claim **9**, wherein the differential is a locking differential or a torque vectoring dual clutch.

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